M.E. (Engineering Design)

2013 Regulations, Curriculum & Syllabi

BANNARI AMMAN INSTITUTE OF TECHNOLOGY

(An Autonomous Institution Affiliated to Anna University, Chennai

Approved by AICTE - Accredited by NBA New Delhi, NAAC with 'A' Grade and ISO 9001:2008 Certified)

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Rules and Regulations

M. E. / M. Tech. Programmes

(For the batch of students admitted in 2013-2014 and onwards)

NOTE: *The regulations hereunder are subject to amendments as may be decided by the Academic Council of the Institute from time to time. Any or all such amendments will be effective from such date and to such batches of students including those already in the middle of the programme) as may be decided by the Academic Council.*

1. Conditions for Admission

(i) Candidates for admission to the I Semester of M. E. / M. Tech. degree programme will be required to satisfy the conditions of admission thereto prescribed by the Anna University, Chennai and Government of Tamil Nadu.

(ii) Part–time candidates should satisfy conditions regarding experience, sponsorship, place of work, etc., that may be prescribed by Anna University, Chennai from time to time, in addition to satisfying requirements as in Clause 1(i).

2. Duration of the Programme

(i) **Minimum Duration:** The programme will lead to the Degree of Master of Engineering (M.E.) / Master of Technology (M. Tech.) of the Anna University, Chennai extend over a period of two years. The two academic years (Part-time three academic years) will be divided into four semesters (Part-time six Semesters) with two semesters per year.

(ii) **Maximum Duration**: The candidate shall complete all the passing requirements of the M. E. / M. Tech. degree programmes within a maximum period of 4 years / 8 semesters in case of full-time programme and 6 years / 12 semesters in case of part-time programme, these periods being reckoned from the commencement of the semester to which the candidate was first admitted.

3. Branches of Study

The following are the branches of study of M.E. / M.Tech. Programmes

M.E.

Branch I	Applied Electronics
Branch II	CAD/CAM
Branch III	Communication Systems
Branch IV	Computer Science and Engineering
Branch V	Embedded Systems
Branch VI	Engineering Design
Branch VII	Power Electronics and Drives
Branch VIII	Software Engineering
Branch IX	Structural Engineering
Branch X	VLSI Design

M. Tech.

Branch I	Biotechnology

4. Structure of Programmes

(i) **Curriculum:** The curriculum for each programme includes Courses of study and detailed syllabi. The Courses of study include theory Courses (including electives), seminar, practicals, Industrial training / Mini-project, Project Work (Phase I) and Project Work (Phase II) as prescribed by the respective Boards of Studies from time to time.

Full-time Programme: Every full-time candidate shall undergo the Courses of his/her programme given in clause 12 in various semesters as shown below:

Semester 1: 6 Theory Courses and two Practicals
Semester 2: 6 Theory Courses, one Practical and a Technical Seminar
Semester 3: 3 Theory Courses and Project Work (Phase I)
Semester 4: Project work (Phase II).

Part-time Programme: Every part-time candidate shall undergo the Courses of his/her programme in various semesters as shown below:

Semester 1: 3 Theory Courses and one Practical
Semester 2: 3 Theory Courses and one Practical
Semester 3: 3 Theory Courses, Technical Seminar and one Practical
Semester 4: 3 Theory Courses
Semester 5: 3 Theory Courses and Project Work (Phase I)
Semester 6: Project Work (Phase II)

(ii) **Theory Courses:** Every candidate shall undergo core theory, elective, and practical Courses including project work of his/her degree programme as given in clause 12 and six elective theory Courses. The candidate shall opt electives from the list of electives relating to his/her degree programme as given in clause 12 in consultation with the Head of the Department. However, a candidate may be permitted to take a maximum of two electives from the list of Courses of other M.E. / M.Tech. Degree programmes with specific permission from the respective Heads of the Departments.

(iii) **Project Work:** Every candidate individually shall undertake the Project Work (Phase I) during the third semester (fifth semester for part-time programme) and the Project Work (Phase II) during the fourth semester (Sixth semester for part-time programme). The Project Work (Phase II) shall be a continuation work of the Project Work (Phase I). The Project Work can be undertaken in an industrial / research organisation or in the Institute in consultation with the faculty guide and the Head of the Department. In case of Project Work at industrial / research organization, the same shall be jointly supervised by a faculty guide and an expert from the organization.

(iv) **Industrial Training / Mini Project:** Every full-time candidate shall opt to take-up either industrial training or Mini Project under the supervision of a faculty guide.

(v) **Value added / Certificate Courses:** Students can opt for any one of the Value added Courses in II and III semester. A separate certificate will be issued on successful completion of the Course.

(vi) **Special Self-Study Elective Courses:** Students can opt for any one of the special elective Courses as Self-Study in addition to the electives specified in the curriculum in II and III semesters, under the guidance of the faculty. The grades of only passed candidates will be indicated in the mark sheet, but will not be taken into account for assessing CGPA.

(vii) **Application oriented and Design Experiments**: The students are to carryout Application oriented and Design Experiments in each laboratory in consultation with the respective faculty and Head of the department.

(viii) **Mini project**: A Mini Project shall be undertaken individually or in a group of not more than 3 in consultation with the respective faculty and the Heads of the Department, in any one of the laboratories from I to III semesters.

(ix) **Credit Assignment:** Each course is normally assigned a certain number of credits with 1 credit per lecture hour per week, 1 credit for 1 or 2 hours of practical per week (2 credits for 3 hours of practical), 4 credits for theory with lab component with 3 hours of lecture and 2 hours of practical per week, 2 credits for 3 hours of seminar per week, 6 credits for the Project Phase I and 12 credits for the Project Phase II. The exact numbers of credits assigned to the different courses of various programmes are decided by the respective Boards of Studies.

(x) **Minimum Credits:** For the award of the degree, the candidate shall earn a minimum number of total credits as prescribed by the respective Board of Studies as given below:

M.E./M. Tech. Programmes	Total Credits
M.E. Applied Electronics	75
M.E. CAD / CAM	75
M.E. Communication Systems	75
M.E. Computer Science and Engineering	75
M.E. Embedded Systems	75
M.E. Engineering Design	77
M.E. Power Electronics and Drives	76
M.E. Software Engineering	76
M.E. Structural Engineering	77
M.E. VLSI Design	75
M.Tech. Biotechnology	76

5. Requirements for Completion of Study of a Semester

(i) a) Candidate will be deemed to have completed the study of any semester only if he /she has kept not less than 70% of attendance in each course and at least 80% of attendance on an average in all courses in that semester put together.
b) On medical grounds, 10% relaxation in the attendance can be allowed
(ii) his/her progress has been satisfactory, and
(iii) his/her conduct has been satisfactory

6. Assessment and Passing Requirements

(i) **Assessment:** The assessment will comprise continuous assessment and final examination, carrying marks as specified in the scheme (clause 10). Continuous assessment will be made as per the guidelines framed by the Institute from time to time. All assessments will be done on absolute marks basis. However, for the purpose of reporting the performance of a candidate, letter grades and grade points will be awarded as per clause 6(v).

(ii) **Final Examinations:** Final examinations will normally be conducted during November / December and during April / May of each year. Supplementary examinations may be conducted at such times as may be decided by the Institute.
A candidate will be permitted to appear for the final examination of a semester only if he/she has completed the study of that semester satisfying the requirements given in clause 5 and registers simultaneously for the examinations of the highest semester eligible and all the Courses which he/she is in arrears of. A candidate, who is not permitted to appear at the final examination of a semester, is not permitted to proceed to the next semester. A candidate who is not permitted to appear at the final examination of any semester has to register for and redo the Courses of that semester at the next available opportunity.

(iii) **Rejoining the Programme:** A candidate who has not completed the study of any semester as per clause 5 or who is allowed to rejoin the programme after a period of discontinuance or who on his/her own request is permitted to repeat the study of any semester, may join the semester which he/she is eligible or permitted to join, only at the time of its normal commencement for a regular batch of candidates and after obtaining the approval from the Director of Technical Education and Anna University, Chennai. No candidate will however be enrolled in more than one semester at any point of time. In the case of repeaters, the earlier continuous assessment in the repeated Courses will be disregarded.

(iv) **Industrial Training, Mini-project and Project Work:**
Every candidate shall submit reports on Industrial training / Mini-project, Project Work (Phase I) and Project Work (Phase II) on dates announced by the Institute / department through the faculty guide to the Head of the Department. If a candidate fails to submit the reports of any of these Courses not later than the specified date, he/she is deemed to have failed in it. Every candidate shall present report/papers in the seminars in each of the relevant semesters about the Industrial training / Mini-project, Project Work (Phase I) and Project Work (Phase II). The reports/papers shall be presented in the seminar before a review committee constituted by the Head of the Department. The Industrial training / Mini-project, Project Work (Phase I) and Project Work (Phase II) will be evaluated based on the presentations in the seminar, reports and viva-voce examinations. In case of the industrial training for the full-time candidates, evaluation will be carried out in the third semester.

In case of Project Work (Phase II), the viva-voce examination will be carried out by a team consisting of an internal examiner, usually the supervisor, and an external examiner, appointed by the Principal.

1. Due weight will be given for the training report from the Organisation / Industry while evaluating the report and its presentation at the seminar about the nature of the training and what the student has learnt. The student shall be required to get a grade not less than "C". The grade will be indicated in the mark sheet. This will not be taken into account for assessing CGPA.
2. The evaluation of the Mini Project will be based on the report, presentation at the seminar and viva-voce. The student shall be required to get a Grade not less than "C". The grade will be indicated in the mark sheet. This will not be taken into account for assessing CGPA.
3. Every Candidate shall pursue Project work-Phase I in third semester and Project Work – Phase II in fourth semester which is in continuation of Phase I. Project work –Phase I and Phase II will be evaluated as given below in the scheme of evaluation

A candidate is permitted to register for the Project Work (Phase II), only after passing the Project Work (Phase I). A candidate who fails in Industrial training / Mini-project, Project Work (Phase I) or Project Work (Phase II) shall register for redoing the same at the beginning of a subsequent semester.

(v) **Letter grade and grade point:** The letter grade and the grade point are awarded based on percentage of total marks secured by a candidate in an individual Course as detailed below:

Range of Percentage of Total Marks	Letter grade	Grade Point (g)
90 to 100	S	10
80 to 89	A	9
70 to 79	B	8
60 to 69	C	7
55 to 59	D	6
50 to 54	E	5
0 to 49 or less than 50% in final examination	RA	0
Incomplete	I	
Withdrawal	W	

"RA" denotes reappearance in the course.
"I" denotes incomplete as per clause 5 (i) & (ii) and hence prevented from writing semester end examination.
"W" denotes withdrawal from the final examination

After completion of the programme earning the minimum number of credits, the Cumulative Grade Point Average (CGPA) from the semester in which the candidate has joined first to the final semester is calculated using the formula:

$$CGPA = \frac{\sum g_i * C_i}{\sum C_i}$$

Where g_i : Grade point secured corresponding to the Course

C_i : Credits allotted to the Course.

(vi) **Passing a Course:** A candidate who secures grade point 5 or more in any Course of study will be declared to have passed that Course, provided a minimum of 50% is secured in the final examination of that Course of study.
A candidate, who is absent for the final examination or withdraws from final examination or secures a letter grade RA (Grade point 0) in any Course carrying continuous assessment and final examination marks, will retain the already earned continuous assessment marks for two subsequent appearances in the examination of that Course and thereafter he/she will be solely assessed by the final examination carrying the entire marks of that Course.
A candidate, who scores a letter grade RA (Grade point 0) in any Course carrying only continuous assessment marks, will be solely examined by a final examination carrying the entire marks of that Course, the continuous assessment marks obtained earlier being disregarded.

7. Qualifying for the Award of the Degree

A candidate will be declared to have qualified for the award of the M.E. / M.Tech. Degree provided:

(i) he/she has successfully completed the Course requirements and has passed all the prescribed Courses of study of the respective programme listed in clause 12 within the duration specified in clause 2.
(ii) No disciplinary action is pending against the candidate

8. Classification of Degree

(i) **First Class with Distinction:** A candidate who qualifies for the award of degree (vide clause 7) having passed all the Courses of all the semesters at the first opportunity within four consecutive semesters (six consecutive semesters for part-time) after the commencement of his / her study and securing a CGPA of 8.5 and above shall be declared to have passed in First Class with Distinction. For this purpose the withdrawal from examination (vide clause 9) will not be construed as an opportunity for appearance in the examination.
(ii) **First Class:** A candidate who qualifies for the award of degree (vide clause 7) having passed all the Courses of all the semesters within a maximum period of six semesters for full-time and eight consecutive semesters for part-time after commencement of his /her study and securing a CGPA of 6.50 and above shall be declared to have passed in First Class.
(iii) **Second Class:** All other candidates who qualify for the award of degree (vide clause 7) shall be declared to have passed in Second Class.

9. Withdrawal from Examination

(i) A candidate may, for valid reasons, be granted permission to withdraw from appearing for the examination in any Course or Courses of only one semester examination during the entire duration of the degree programme. Also, only one application for withdrawal is permitted for that semester examination in which withdrawal is sought.
(ii) Withdrawal application shall be valid only if the candidate is otherwise eligible to write the examination and if it is made prior to the commencement of the semester examinations and also recommended by the Head of the Department and the Principal.
(iii) Withdrawal shall not be construed as an opportunity for appearance in the examination for the eligibility of a candidate for First Class with Distinction.

10. Scheme of Assessment

- Students who were absent for the previous periodicals and those who wish to improve their periodical test marks shall take up an optional test consisting of two units prior to the commencement of model examination.

Scheme of Evaluation

i) Theory

Final Examination	: 50 Marks
Internal Assessment	: 50 Marks

Distribution of marks for internal assessment:

Assignment/Tutorial	: 05	
Test 1	: 10	
Test 2	: 10	
Model Exam	: 15	(Entire syllabus)
Innovative Presentation[#]	: 10	
	: 50	

[#] Innovative Presentation includes Seminar / Quiz / Group Discussion / Case Study /Soft Skill Development / Mini Project / Review of State-of-the art

ii) Technical Seminar **:** 100 Marks

Three Seminars (3 × 25)	: 75 Marks
Report	: 25 Marks

iii) Practical

Final Examination	: 50 Marks
Internal Assessment	: 50 Marks

Distribution of marks for internal assessment:

Preparation	: 5
Conduct of Experiments	: 10
Observation & Analysis of results	: 10
Record	: 10
Model Exam & Viva-voce	: 15
	: 50

iv) Project Work Phase – I & Viva Voce

	Marks
Internal	
Project Identification	: 10
Literature survey + analysis	: 15
Sub Total	: 25
Approach & Progress	: 25
Total	: 50
External – Final Evaluation	
Report Preparation & Presentation	: 25
Viva Voce	: 25
	: 50

v) Project Work Phase – II

	Marks
Internal	
Continuation of Approach & Progress	: 50
Findings, Discussion & Conclusion	: 50
Total	: 100
External – Final Evaluation	
Report Preparation & Presentation	: 50
Viva Voce	: 50
	: 100

11 . Question paper pattern for Theory Examination

Max. Marks	: 100
Time	: 3 Hours

PART A
Short Answer Questions: 15
(15 × 2 Marks) : 30 Marks
(Three Questions from each unit)

PART B
Lengthy Answer Questions: 2
(2 × 14 Marks) *(Compulsory)* : 28
(Questions may be framed from any of the five units)
Lengthy Answer Questions: 3
(3 × 14 Marks) *(Either Or Type)* : 42
(Questions may be framed from the remaining three units)

Total Marks : 100

12. Curriculum and Syllabi

Program Educational Objectives (PEOs)

I. Fundamental technical knowledge and skills in mathematics and engineering to recognize, analyze and solve problems, and to apply these skills to the generation of new knowledge, ideas in industry; and for implement these solutions in practice.

II. Apply the principles of manufacturing and materials with the aid of computer in order to develop or improve products and techniques.

III. Produce postgraduates are competent engineers and work is notable for its breadth and its technical excellence.

IV. Provide a “hands-on” approach to engineering so that the postgraduates develop an understanding of engineering judgment and practice.

Programme Outcomes (POs)

a. ability to work effectively in a team, exercise initiative, and function as a leader

b. ability to design and conduct experiments to analyze the data

c. ability to design a system or process to meet the desired needs and solving engineering problems

d. ability to identify potential changes in behavior and properties of materials as they are altered and influenced by manufacturing processes

e. ability to research concepts, simulate, test working conditions and application of modeling methods and their impact on the designed systems

f. ability to solve open-ended engineering problems in Engineering Design areas including the design and realization of such systems

g. the attitudes, abilities and skills required to adapt to rapidly changing technologies and the ability to pursue life-long learning

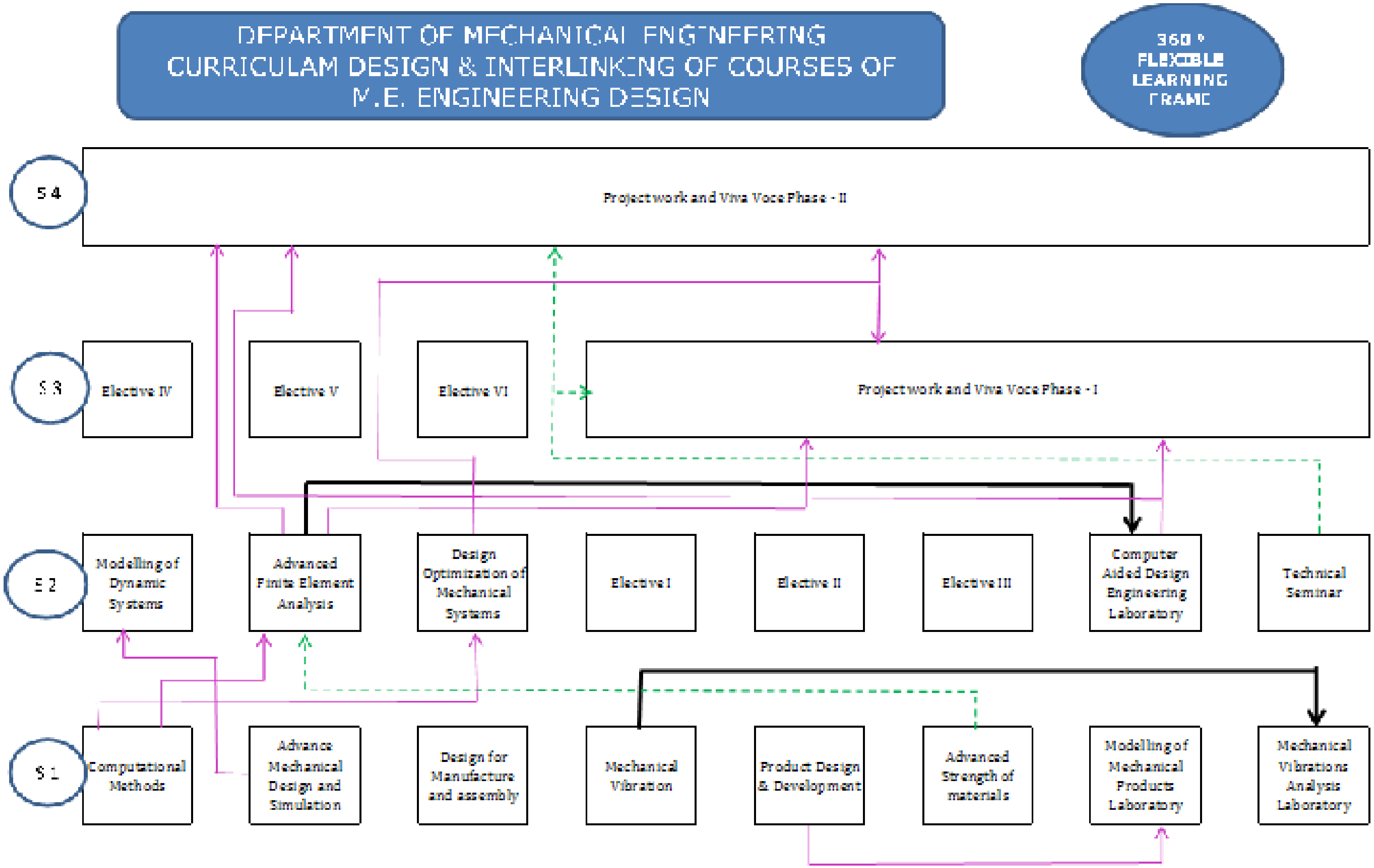
h. an understanding of all aspects of the design process including functional, creativity in the design of systems, processes and esthetic considerations

i. ability to identify engineering problems, and to carry out the engineering design of a system or component to meet desired needs, using modern tools for complex design

j. an understanding of contemporary issues and the ability to assess the impact of engineering solutions on the community.

Mapping of PEOs with POs

PEOs	POs
I. Fundamental technical knowledge and skills in mathematics and engineering to recognize, analyze and solve problems, and to apply these skills to the generation of new knowledge, ideas in industry; and to implement these solutions in practice	b. ability to design and conduct experiments, to analyze the data f. ability to solve open-ended engineering problems in design engineering areas including the design and realization of such systems g. the attitudes, abilities, and skills required to adapt to rapidly changing technologies and the ability to pursue life-long learning.
II. Apply the principles of manufacturing and materials with the aid of computer in order to develop or improve products and techniques.	c. ability to design a system, or process to meet desired needs and solve engineering problems d. ability to identify potential changes in behavior and properties of materials as they are altered and influenced by manufacturing processes e. ability to research concepts, simulate, test working conditions and application of modeling methods and their impact on the designed systems
III. Produce postgraduates who are competent engineers work is notable for its breadth and its technical excellence	h. an understanding of all aspects of the design process including functional, creativity in the design of systems, components or processes and esthetic considerations. i. ability to identify engineering problems, and to carry out the engineering design of a system or component to meet desired needs, using modern tools for complex design.
IV. Provide a "hands-on" approach to engineering so that the postgraduates develop an understanding of engineering judgment and practice	a. ability to work effectively in a team, exercise initiative, and function as a leader j. an understanding of contemporary issues and the ability to assess the impact of engineering solutions on the community.


DEPARTMENT OF MECHANICAL ENGINEERING
CURRICULAM DESIGN & INTERLINKING OF COURSES OF
M.E. ENGINEERING DESIGN
360 ° FLEXIBLE LEARNING FRAME
S 4
Project work and Viva Voce Phase - II
S 3
Elective IV
Elective V
Elective VI
Project work and Viva Voce Phase - I
S 2
Modelling of Dynamic Systems
Advanced Finite Element Analysis
Design Optimization of Mechanical Systems
Elective I
Elective II
Elective III
Computer Aided Design Engineering Laboratory
Technical Seminar
S 1
Computational Methods
Advance Mechanical Design and Simulation
Design for Manufacture and assembly
Mechanical Vibration
Product Design & Development
Advanced Strength of materials
Modelling of Mechanical Products Laboratory
Mechanical Vibrations Analysis Laboratory

Curriculum: Regulation 2013

M.E. Engineering Design (Full Time)

First Semester							
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**
		PEOs	**POs**				
13ED11	Computational Methods	I	(b), (e)	3	1	0	4
13ED12	Advanced Mechanisms Design and Simulation	III	(e), (f), (h)	3	1	0	4
13ED13	Design for Manufacture and Assembly+	III	(h), (i)	3	0	0	3
13ED14	Mechanical Vibrations	II	(e), (f), (i)	3	1	0	4
13ED15	Product Design and Development	III	(e), (f), (j)	3	0	0	3
13ED16	Advanced Strength of Materials+	III	(c), (d), (i)	3	1	0	4
13ED17	Modeling of Mechanical Products Laboratory	III	(a), (b), (f)	0	0	3	2
13ED18	Mechanical Vibrations Analysis Laboratory	II	(c), (e), (i)	0	0	3	2
			Total	**18**	**5**	**6**	**26**
Second Semester							
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**
		PEOs	**POs**				
13ED21	Model Analysis and Dynamic Systems+	II	(c), (e), (f)	3	1	0	4
13ED22	Advanced Finite Element Analysis+	IV	(c), (f), (i)	3	1	0	4
13ED23	Design Optimization of Mechanical Systems+	I	(c), (e), (i)	3	1	0	4
	Elective	-	-	-	-	-	3
	Elective	-	-	-	-	-	3
	Elective	-	-	-	-	-	3
13ED24	Computer Aided Design Engineering Laboratory	II	(a), (b), (e)	0	0	3	2
13ED25	Technical Seminar	I	(g)	0	0	2	1
			Total	**9**	**3**	**5**	**24**
Third Semester							
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**
		PEOs	**POs**				
	Elective			3	0	0	3
	Elective			3	0	0	3
	Elective			3	0	0	3
13ED31	Project Work and Viva voce Phase – I	IV	(e), (f), (g)				6
			Total	**-**	**-**	**-**	**15**
Fourth Semester							
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**
		PEOs	**POs**				
13ED41	Project Work and Viva voce Phase – II	IV	(e), (f), (g)	-			12
			Total	-			**12**

+ Common with CAD/CAM

Note: Hours & Credit Pattern: Minimum number of credits to be earned for the award of M.E. (Engineering Design) Programme: 77

M.E. Engineering Design (Part Time)

First Semester							
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**
		PEOs	**POs**				
13ED11	Computational Methods	I	(b), (e)	3	1	0	4
13ED12	Advanced Mechanisms Design and Simulation	III	(e), (f), (h)	3	1	0	4
13ED13	Design for Manufacture and Assembly +	III	(h), (i)	3	0	0	3
13ED17	Modeling of Mechanical Products Laboratory	III	(a), (b), (f)	0	0	3	2
			Total	**9**	**3**	**3**	**13**
Second Semester							
Code No.	**Course**	**PEOs**	**POs**	**L**	**T**	**P**	**C**
13ED21	Model Analysis and Dynamic Systems +	II	(c), (e), (f)	3	1	0	4
13ED22	Advanced Finite Element Analysis +	IV	(c), (f), (i)	3	1	0	4
13ED23	Design Optimization of Mechanical Systems +	I	(c), (e), (i)	3	1	0	4
13ED24	Computer Aided Design Engineering Laboratory	II	(a), (b), (e)	0	0	3	2
			Total	**9**	**3**	**3**	**14**
Third Semester							
13ED14	Mechanical Vibrations	II	(e), (f), (i)	3	1	0	4
13ED15	Product Design and Development	III	(e), (f), (j)	3	0	0	3
13ED16	Advanced Strength of Materials +	III	(c), (d), (i)	3	1	0	4
13ED18	Mechanical Vibrations Analysis Laboratory	II	(c), (e), (i)	0	0	3	2
			Total	**9**	**2**	**3**	**13**
Fourth Semester							
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**
		PEOs	**POs**				
	Elective			3	0	0	3
	Elective			3	0	0	3
	Elective			3	0	0	3
13ED25	Technical Seminar	I	(g)	0	0	2	1
			Total	**9**	**0**	**2**	**10**
Fifth Semester							
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**
		PEOs	**POs**				
	Elective			3	0	0	3
	Elective			3	0	0	3
	Elective			3	0	0	3
13CC31	Project Work and Viva voce Phase – I	IV	(e), (f), (g)				6
			Total	**-**	**-**	**-**	**15**
Sixth Semester							
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**
		PEOs	**POs**				
13ED41	Project Work and Viva voce Phase – II	IV	(e), (f), (g)		-		12
			Total		-		**12**

+ Common with CAD/CAM

Note: Hours & Credit Pattern: Minimum number of credits to be earned for the award of M.E. (Engineering Design) Programme: 77

List of Electives							
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**
		PEOs	**POs**				
13ED51	Applied Elasticity and Plasticity	III	(d), (e), (j)	3	0	0	3
13ED52	Design of Hydraulic and Pneumatic Systems +	I	(b), (c), (e)	3	0	0	3
13ED53	Design of Material Handing Equipment +	I	(c), (d)	3	0	0	3
13ED54	Design of Thermal Systems +	I	(c), (e), (f)	3	0	0	3
13ED55	Mechatronics System Design +	II	(c), (e), (f)	3	0	0	3
13ED56	CAD/CAM	III	(c), (e), (g)	3	0	0	3
13ED57	Design and Manufacturing of Composite Materials +	III	(b), (d), (f)	3	0	0	3
13ED58	Rapid Prototyping and Tooling +	IV	(c), (e), (f)	3	0	0	3
13ED59	TRIZ for Product Innovation *	III	(h), (i), (j)	3	0	0	3
13ED60	Tribology in Design +	I, III	(e), (e), (i)	3	0	0	3
13ED61	Industrial Robotics +	III	(g), (h), (i)	3	0	0	3
13ED62	Reliability Engineering and Total Productive Maintenance	III	(c), (f), (g)	3	0	0	3
13ED63	Advanced Tool Design +	I, III	(c), (i), (j)	3	0	0	3
13ED64	Design of Mechanical Drives	III	(c), (e), (f)	3	0	0	3
13ED65	Rotor Dynamics	I	(d), (e), (f)	3	0	0	3
13ED66	Nanomaterials and Nanotechnology *	III	(d), (e), (i)	3	0	0	3
13ED67	Micro Electro Mechanical Systems Design +	III	(c), (d), (e)	3	0	0	3
13ED68	Failure Analysis and Design	I	(d), (e), (f)	3	0	0	3
13ED69	Geometric Modeling +	II	(c), (e)	3	0	0	3
13ED70	Design of Automotive Systems +	III	(e), (f), (h)	3	0	0	3
13ED71	Computational Fluid Dynamics +	I	(c), (e), (f)	3	0	0	3
13ED72	Product Reliability +	III	(c), (e), (f)	3	0	0	3
13ED73	Productions and Operations Management +	IV	(c), (e), (f)	3	0	0	3
13ED74	Mechanics of Fracture	I	(e), (f), (i)	3	0	0	3

+ Common with CAD/CAM
* Open Elective

13ED11/13CC11 COMPUTATIONAL METHODS

3 1 0 4

Course Objectives (COs):

- Acquire the knowledge to find approximate solution of system of linear and non-linear equation by using computational method.
- Ability to solve boundary value problem and characteristics value problem by using suitable method.
- Ability to find solution of partial differential equation using numerical methods.

Course Learning Outcomes (CLOs):

1. Acquire more knowledge in basic concept of engineering mathematics.
2. Improvement in problem evaluation technique.
3. Choose an appropriate method to solve a practical problem.

Programme Outcomes (PO):

(b) Ability to design and conduct experiments to analyze the data

(e) Ability to research concepts, simulate, test working conditions and application of modeling methods and their impact on the designed systems.

Unit I

Solution of System of Linear and Nonlinear Equations and Curve Fitting

Examples, Solving Sets of Equations, Gauss Elimination Method, Choleski Method, Iterative Methods, Relaxation Method, System of Non-Linear Equations- Newton Raphson Method- Least Square Approximation, Fitting of Non-Linear Curves By Least Squares

12 Hours

Unit II

Numerical Integration: Newton-Cotes Integration

Formulas, Trapezoidal rule, Simpson's rules, Gaussian quadrature, adaptive integration, cubic spline functions - Bezier curves and B-splines

12 Hours

Unit III

Boundary Value Problems and Characteristic Value Problems

Shooting method, solution through a set of equations, derivative boundary conditions, Rayleigh-Ritz method, characteristic value problems, solution using characteristic polynomial method, Jacobi method, power method and Inverse power method

12 Hours

Unit IV

Numerical Solution of Partial Differential Equations

Laplace's equation: Laplace's equations, representations as a difference equation, Iterative methods for Laplace's equations, Poisson equation, derivative boundary conditions, irregular and non-rectangular grids, Matrix patterns, ADI method, applications to heat flow problems

12 Hours

Unit V

Parabolic and Hyperbolic Partial Differential Equations: Explicit method

Crank-Nicholson method, derivative boundary condition, stability and convergence criteria, Parabolic equations in two or more dimensions, applications to heat flow problems-Hyperbolic Partial differential equations: Solving wave equation by finite differences, stability of numerical method, method of characteristics, Wave equation in two space dimensions

12 Hours

Total: 60 Hours

References

1. C. F. Gerald and P. O. Wheatley, *Applied Numerical Analysis,* Pearson Education, 2003.
2. P.Kandasamy, K. Thilagavathy and K. Gunavathy, *Numerical methods,* S Chand & Co., New Delhi, 2007.
3. S. Rajasekaran, *Numerical Methods in Science and Engineering – A Practical Approach*, Wheeler Publishing, 2005.
4. J.D. Faires and R. Burden, *Numerical Methods*, Brooks/Cole Publishing Company, 2006.
5. C.S.Chapra and P.R. Canale, *Numerical Methods for Engineers with Software and Programming Applications*, Tata McGraw Hill, 2004.

13ED12 ADVANCED MECHANISMS DESIGN AND SIMULATION

3 1 0 4

Course Objectives (COs):

- To understand the layout of linkages in the assembly of a system/machine.
- To study the principles involved in assessing the displacement, velocity and acceleration at any point in a link of a mechanism.
- To analyze the motion resulting from a specified set of linkages in a mechanism.

Course Learning Outcomes (CLOs):

1. Designing the linkages for particular applications.
2. Analyze the velocity and acceleration of various mechanisms.
3. Selecting the topological arrangements of robotic arm for specific applications
4. Interpret interrelationship between forces of various members and mechanisms

Programme Outcomes (PO):

(e) Ability to research concepts, simulate, test working conditions and application of modeling methods and their impact on the designed systems.

(f) Ability to solve open-ended engineering problems in Engineering Design areas including the design and realization of such systems

(h) An understanding of all aspects of the design process including functional, creativity in the design of systems, processes and esthetic considerations

Unit I
Introduction
Introduction to kinematics and mechanisms - Kinematics diagram, Degrees of freedom – Formation of one D.O.F, multi loop kinematic chains - Mechanism design philosophy, design categories and mechanism parameters - Network formula - Gross motion concepts -

12 Hours

Unit II
Kinematic Analysis
Position Analysis – Vector loop equations and Analytical methods for four bar - Slider crank - Inverted slider crank - Geared five bar - Analytical methods for velocity and acceleration Analysis - Graphical synthesis - Displacement – Velocity and acceleration analysis of simple mechanisms - Goodman analysis - Auxiliary point method

12 Hours

Unit III
Path Curvature Theory
Fixed and moving centrodes - inflection points and inflection circle - Euler Savary equation - Bobillier's construction - Hartmann's construction – Graphical constructions – Cubic of stationary curvature.

12 Hours

Unit IV
Synthesis of Mechanisms
Type synthesis – Number synthesis – Associated Linkage Concept - Dimensional synthesis - Function generation - Path generation - Motion generation.- Graphical methods - Cognate linkages - Coupler curve synthesis - Design of six-bar mechanisms - Algebraic methods- Application of instant center in linkage design.

12 Hours

Unit V
Kinematics of Robot
Introduction - topology arrangements of robotics arms - Kinematic analysis of spatial RSSR mechanism – Denavit - Hartenberg parameters - Forward and inverse kinematics of robotic manipulators. Study and use of Mechanism using Simulation Soft-ware packages.

12 Hours
Total: 60 Hours

References

1. J. J.Uicker, G. R. Pennock and J.E.Shigley, *Theory of Machines and Mechanisms*, Oxford University Press, NY, 2003.
2. N.G. Sandor and G.A. Erdman, *Advanced Mechanism Design*, Vol. 1, Prentice Hall India Pvt., Ltd, 2001.
3. Amitabha Ghosh and Asok Kumar Mallik, *Theory of Mechanism and Machines*, EWLP, Delhi, 2002.
4. R.L.Nortron , *Design of Machinery*, McGraw Hill, 2004.
5. J.Kenneth , Waldron, L.Gary , and Kinzel, Kinematics, *Dynamics and Design of Machinery*, John Wiley-Sons, 2003.

13ED13 / 13CC13 DESIGN FOR MANUFACTURE AND ASSEMBLY

3 1 0 4

Course Objectives (COs):

- To introduce the basic concepts and design guidelines of different manufacturing processes.
- To make the student familiar with solving different problems in design modifications of the product related to various manufacturing techniques.

Course Learning Outcomes (CLOs):

1. Selection of material based on manufacturing process, design and assembly
2. Usage of DFMA tools for minimizing effort and cost in manufacturing
3. Designing of components based on environmental issues
4. Considerations in casting and machining to facilitate easy manufacturing

Programme Outcomes (PO):

(h) An understanding of all aspects of the design process including functional, creativity in the design of systems, processes and esthetic considerations

(i) Ability to identify engineering problems, and to carry out the engineering design of a system or component to meet desired needs, using modern tools for complex design.

Unit I

Introduction to Tolerances

Tolerances: Limits and Fits, tolerance Chains and identification of functionally important dimensions. Dimensional chain analysis-equivalent tolerances method, equivalent standard tolerance grade method, equivalent influence method. Geometric tolerances: applications, geometric tolerancing for manufacture as per Indian Standards and ASME Y 14.5 standard, surface finish- R*eview of relationship between attainable tolerance grades and different machining*

12 Hours

Unit II

Form Design Of Castings, Weldments, Forging and Sheet Metal Components

Materials choice - Influences of materials - Space factor - Size - Weight - Surface properties and production method on form design. Redesign of castings based on parting line considerations, Minimizing core requirements, redesigning cast members using Weldments-F*orm design aspects in Forging and sheet metal components*

12 Hours

Unit III

Component Design - Machining Considerations

Design features to facilitate machining - Drills - Milling cutters - Keyways - Doweling procedures, Counter sunk screws - Reduction of machined area - Simplification by separation - Simplification by amalgamation - Design for machinability - Design for economy - Design for clampability - Design for accessibility - Design for assembly. Redesign For Manufacture - Design features to facilitate machining: datum features - functional and manufacturing.-*Component design – machining considerations, redesign for manufacture, examples*

12 Hours

Unit IV

DFMA Tools

Rules and methodologies used to design components for manual, automatic and flexible assembly, traditional design and manufacture Vs concurrent engineering, DFA index, poke-yoke, lean principles, six sigma concepts, DFMA as the tool for concurrent engineering, three DFMA criteria for retaining components for redesign of a product; design for manual assembly; design for automatic assembly- *Computer-aided design for assembly using software.*

12 Hours

Unit V

Design for the Environment

Introduction – Environmental objectives – Global issues – Regional and local issues – Basic DFE methods – Design guide lines – Example application – Lifecycle assessment – Basic method – AT&T's environmentally responsible product assessment - Weighted sum assessment method – Lifecycle assessment method – Techniques to reduce environmental impact – Design to minimize material usage – Design for disassembly – Design for Recyclability – Design for remanufacture-*Design for energy efficiency – Design to regulations and standards*

12 Hours

Total: 60 Hours

References

1. A.K. Chitale and R. C. Gupta, *Product Design and Manufacturing*, PHI 2007.
2. G.Boothroyd, P.Dewhurst and W.Knight, *Product Design for Manufacture and Assembly*, Marcell Dekker, 2002.
3. R.Bryan , Fischer, *Mechanical Tolerance stackup and analysis,* Marcell Dekker, 2004.
4. M. F. Spotts, *Dimensioning and Tolerance for Quantity Production*, Prentice Hall Inc., 2002.
5. J.G. Bralla, *Hand Book of Product Design for Manufacturing*, McGraw Hill Publications, 2000.
6. Daniel Witney; Mechanical assembly

13ED14 / 13CC16 MECHANICAL VIBRATIONS

3 1 0 4

Course Objectives (COs):

- To impart knowledge on the sources of vibration and noises in automobiles and make design modifications to reduce the vibration and noise and improve the life of the components
- To create expertise in vibration measurement and control

Course Learning Outcomes (CLOs):

1. Able to detect the problem of machine tool vibration
2. Analyzing the problem to get rid of any machine vibration problem.

Programme Outcomes (PO):

(e) Ability to research concepts, simulate, test working conditions and application of modeling methods and their impact on the designed systems.
(f) Ability to solve open-ended engineering problems in Engineering Design areas including the design and realization of such systems
(i) Ability to identify engineering problems, and to carry out the engineering design of a system or component to meet desired needs, using modern tools for complex design.

Unit I
Fundamentals of Vibration
Introduction to Single degree freedom systems – Duhamel’s Integral – Impulse Response function – Virtual work – Lagrange’s equation – Single degree freedom forced vibration with elastically coupled viscous dampers – Transient Vibration - *Railway dynamics and ground vibration*

12 Hours

Unit II
Two Degree Freedom System
Free vibration of spring-coupled system – Mass coupled system – Vibration of two degree freedom system – Forced vibration of spring-coupled system – Mass coupled system – Vibration Absorber - *Multi-body dynamics and control*

12 Hours

Unit III
Multi-Degree Freedom System
Normal mode of vibration – Flexibility Matrix and Stiffness matrix – Eigen values and Eigen vectors – orthogonal properties – Forced Vibration by matrix inversion – Modal damping in forced vibration – Stodala - Matrix iteration – Holzer - Mechanical impedance - Rayleigh methods - *Durability testing - vibration control*

12 Hours

Unit IV
Vibration of Continuous Systems
Systems governed by wave equations – Vibration of strings – Vibration of rods – Euler Equation for Beams – Effect of Rotary inertia and shear deformation **-** *Dynamics of rotating machinery , Dynamic testing: methods and instrumentation*

12 Hours

Unit V
Experimental Methods in Vibration Analysis
Vibration instruments – Vibration exciters Measuring Devices – Analyzers – Vibration Tests – Free and Forced Vibration tests. Examples of Vibration tests & Noise Vibration and Harshness test - *Acoustic testing, Active noise and vibration control*

12 Hours
Total: 60 Hours

References

1. Thomson W.T. *Theory of Vibration with Applications*, CBS Publishers and Distributors, New Delhi, 2006.
2. Rao J.S., & Gupta, K. "Ind. Course on Theory and Practice Mechanical Vibration", New Age International (P) Ltd., 2003.
3. W. T.Thomson, Theory of Vibration with Applications, Printice Hall of India, 2003.
4. A.K. Mallik, Principles of Vibration Control, Affiliated East-West Press Pvt. Ltd, 2004.
5. S. S.Rao, Mechanical Vibrations, Pearson Eduction, 2004.
6. S.Graham Kelly and Shashidar K.Kudari, Mechanical Vibrations, Tata McGraw-Hill Publishing Company Ltd New Delhi, 2007.
7. R.N. Iyengar , Elements of Mechanical Vibration, I K International Publishing House Pvt. Ltd, New Delhi, 2007
8. http://nptel.iitm.ac.in/video.php?courseId=1123
9. www.vibetech.com/techpaper.htm

13ED15 PRODUCT DESIGN AND DEVELOPMENT

3 0 0 3

Course Objectives (COs):

- To gain knowledge on the challenges of product development & customer needs.
- To understand the standard procedure available for concept development.
- To learn to use design process.
- To familiarize the students with the Intelligent property rights.

Course Learning Outcomes (CLOs):

1. Able to select concepts for various product development.
2. Capability of selecting materials, making experimental plan.
3. Strengthen the decision making skills of the students.

Programme Outcomes (PO):

(e) Ability to research concepts, simulate, test working conditions and application of modeling methods and their impact on the designed systems.

(f) Ability to solve open-ended engineering problems in Engineering Design areas including the design and realization of such systems

(j) An understanding of contemporary issues and the ability to assess the impact of engineering solutions on the community.

Unit I
Introduction
Product Development – Characteristics, Duration, Challenges, Organizations. Development Process –Processes, Process Flow. Product Planning – Identifying Opportunities, Prioritization, Resource allocation and Pre-Project Planning. Customer Needs – Data gathering, Organizing Needs

9 Hours

Unit II
Concept Development
Product and Target specification, various steps in concept generation, Brainstorming, Morphological analysis, Selection of Concepts – Subjective decision-making, Criteria ranking, Criteria weighting, Datum method, EVAD (Design Evaluation) method, Principles of Computer aided decision making

9 Hours

Unit III
Design Process
Concept Testing – Survey, Response and Interpretation. Product Architecture, Platform planning, System level design issues. Embodiment design - Introduction, Size and strength, Scheme drawing, Form design, Provisional material and process determination, Design for assembly and manufacture, Industrial design. Modeling - Introduction, Mathematical modeling, Optimization, Scale models, Simulation

9 Hours

Unit IV
Planning for Manufacture and Management
Detail Design - Factor of safety, Selection procedure for bought out components, Material Selection, Robust design, Experimental Plan. Design Management - Management of design for quality, Project planning and control, Production design specification (PDS), Quality function deployment (QFD)-process, Design review, Value analysis/engineering

9 Hours

Unit V
Intellectual Property Rights and Project Economics
Intellectual Property Rights – Introduction, Study prior inventions, Write the description of the invention, Refine Claims, Pursue application. Economics and Management – Financial Model, Project Trade – Off, Accelerating Projects, Project Execution

9 Hours
Total: 45 Hours

References

1. G. E. Dieter, *Engineering Design*, McGraw – Hill International, 2009.
2. T. Karl, Ulrich and D. Steven, and Eppinger, *Product Design and Development*, McGraw Hill 2009.
3. Ken Hurst, *Engineering Design Principles*, Elsevier Science and Technology Books, 2006.
4. E. Deborah and Bouchoux, *Intellectual Property Rights*, Cengage Learning India Pvt., 2008.

13ED16 / 13CC66 ADVANCED STRENGTH OF MATERIALS

4 0 0 4

Course Objectives (COs):

- To impart knowledge on simple stresses, strains and deformation in components due to external loads and their relations, provide knowledge in shear centre and unsymmetrical bending.
- To impart knowledge on stresses induced in curved flexible members, stresses in flat plates and torsion of non-circular sections, to study the stress due to rotary sections and contact Stresses.

Course Learning Outcomes (CLOs):

1. Relate the mechanical properties of materials to their structure.
2. Select materials for structural applications.
3. Solve realistic and/or fundamental problems relating to the mechanical behavior of materials for individual solutions and tests.
4. Work in teams for the materials selection in design.

Programme Outcomes (PO):

(c) Ability to design a system or process to meet the desired needs and solving engineering problems

(d) Ability to identify potential changes in behavior and properties of materials as they are altered and influenced by manufacturing processes.

(i) Ability to identify engineering problems, and to carry out the engineering design of a system or component to meet desired needs, using modern tools for complex design.

Unit I
Elasticity
Stress - Stress at a point, stress tensor, stress concentration factor, stress transformations, principal stresses, octahedral stress, equations of equilibrium Strain relations and general equations of elasticity in Cartesian - Polar and spherical coordinates differential equations of equilibrium-compatibility -Boundary conditions - Representation of three-dimensional stress of a tension generalized hook's law - St. Venant's principle - *measurement of surface strain using strain gauge*

12 Hours

Unit II
Shear Center and Unsymmetrical Bending
Location of shear center for various sections - Shear flows - Stresses and deflections in beams subjected to unsymmetrical loading - Kern of a section - ***Shear center of box beams.***

12 Hours

Unit III
Curved Flexible Members and Stresses in Flat Plates
Circumference and radial stresses - Deflections-curved beam with restrained ends - Closed ring subjected to concentrated load and uniform load - chain links and crane hooks - Stresses in circular and rectangular plates due to various types of loading and end conditions buckling of plates - *Fully plastic loads for curved beams*

12 Hours

Unit IV
Torsion of Non-Circular Sections
Torsion of rectangular cross section - S.Venants theory - Elastic membrane analogy Prandtl's stress function torsional stress in hollow thin walled tubes - *Thin-wall torsion member with restrained ends*.

12 Hours

Unit V
Stresses Due to Rotary Sections and Contact Stresses
Radial and tangential stresses in solid disc and ring of uniform thickness and varying thickness allowable speeds - Methods of computing contact stress-deflection of bodies in point and line contact applications - *Effect of magnitude of friction coefficient*

12 Hours
Total: 60 Hours

Reference(s)

1. Timoshenko and Goodier, *Theory of Elasticity*, McGraw Hill Publications, 2003.
2. A. P. Boresi, R. J. Schmidt and O. M. Sidebottom, *Advanced Mechanics of Materials*, John Wiley and Sons, Inc., 2008.
3. Seely and Smith, *Advanced Mechanics of Materials*, John Wiley International Edn, 2002.
4. Rimoahwnko, *Strength of Materials*, Van Nostrand, 2004
5. Wang, *Applied Elasticity*, McGraw Hill, 2006
6. Robert D. Cook, Warren C. Young, *Advanced Mechanics of Materials*, Mc-Millan Pub. Co., 2008
7. L.S.Srinath, *Advanced mechanics of solid*, TataGraw Hill Education,Second reprint,2008
8. http://nptel.iitm.ac.in/video.php?courseId=1006

13ED17 / 13CC17 MODELING OF MECHANICAL PRODUCTS LABORATORY

0 0 3 2

Course Objectives (COs):

- To develop skill on creating of 2D / 3D models, surface models using any one of modeling software.
- To understand the concept of various tolerances and fits used for component design.
- To understand and practice the drawings of machine components and simple assemblies using modeling packages.
- To impart knowledge on simulation of different mechanisms like 4-bar, slider and cam mechanisms using any one of modeling software.

Course Learning Outcomes (CLOs):

1. Model 2D / 3D drawings of any mechanical products using modeling software
2. Analyze the tolerance and limits in the given drawings.
3. Draw the gear and different kind of mechanism with simulation

Programme Outcomes (PO):

(a) Ability to work effectively in a team, exercise initiative, and function as a leader
(b) Ability to design and conduct experiments to analyze the data.
(f) Ability to solve open-ended engineering problems in Engineering Design areas including the design and realization of such systems

List of Experiments

1. Modeling and Assembling of Machine Vice
2. Create an assembly model of tailstock
3. Modeling of connecting rod
4. Modeling of butterfly Valve Assembly
5. Modeling of Pulley Support Assembly
6. Modeling of Fixture Assembly
7. Modeling of Shaper Tool Head Assembly
8. Surface Modeling of Piston
9. Simulation of Cam & Follower
10. Simulation of Slider Crank Mechanisms
11. Simulation of Four bar Mechanism
12. Simulation of Spur Gear Drive.

Total: 45 Hours

13ED18 MECHANICAL VIBRATIONS ANALYSIS LABORATORY

0 0 3 2

Course Objectives (COs):

- To develop skill on vibration measurement, data acquisition and control of vibrations, modeling, simulation and analysis.
- To provide knowledge and skill on various vibration device, analysis packages.

Course Learning Outcomes (CLOs):

1. Capability of increasing the vibration system analysis skill of any mechanical systems.
2. Capability of developing the control system integration with vibration measuring various devices.
3. Improving the skill of integration of various disciplines.

Programme Outcomes (PO):

(c) Ability to design a system or process to meet the desired needs and solving engineering problems

(e) Ability to research concepts, simulate, test working conditions and application of modeling methods and their impact on the designed systems.

(i) Ability to identify engineering problems, and to carry out the engineering design of a system or component to meet desired needs, using modern tools for complex design.

List of Exercises

1. A Study of Vibration Measuring Instruments and Vibration Analysis procedures using Lab View and MATLAB
2. Determination of natural Frequency, displacement, acceleration and velocity of vibration in the given Machine Tool (Lathe, Drilling, milling and slotting machine and etc.) using Accelerometer and Data Acquisition Method in the LABVIEW.
3. Modeling and simulation of given Kinematic Link Mechanism (slider crank mechanism, quick return mechanism and whit-worth mechanism etc.) Using ADAMS and interpret the results.
4. Digital Simulation of given Linear System /Nonlinear System (Step, Ramp and Sine Wave signal) using MATLAB and interpret the results.
5. Frequency Response Analysis (Draw the Phase Margin and Gain Margin, Bode Plots) of given system using MATLAB and evaluate the system Stability.
6. Determination of natural frequency, displacement, acceleration and velocity of vibration in given string vibration analysis using non-contact Laser sensor and interpret the results.
7. Determination of suspension travel limit and acceleration of automobile suspension system using Quarter car suspension test rig.
8. Determination of natural Frequency, displacement and acceleration of 1DOF m-k system using virtual instrumentation module.
9. Modeling and simulation of semi-vehicle suspension system and estimate the variation of vibration parameters in the system.
10. The stability analysis of given linear system by Root Locus / Nyquist Plot Method using MATLAB and evaluate the system Stability.
11. Study the three term (PID) controller and its effects on the feedback loop response. Investigate the characteristics of the proportional (P), the integral (I), and the derivative (D) controls, and how to use them to obtain a desired response using MATLAB.

Total: 45 Hours

13ED21 / 13CC59 MODEL ANALYSIS AND DYNAMIC SYSTEMS

4 0 0 4

Course Objectives (COs):

- To develop mathematical modeling skill of students.
- To impart knowledge on feedback and control systems, time response and frequency response.
- To develop the kill for using the components from the various discipline.

Course Learning Outcomes (CLOs):

1. Capability of increasing the mathematical modeling skill of any mechanical systems.
2. Capability of finding system's stability in the various conditions.
3. Increasing the skill of integration of various disciplines.

Programme Outcomes (PO):

(c) Ability to design a system or process to meet the desired needs and solving engineering problems

(e) Ability to research concepts, simulate, test working conditions and application of modeling methods and their impact on the designed systems.

(f) Ability to solve open-ended engineering problems in Engineering Design areas including the design and realization of such systems

Unit I

Introduction to control systems and mathematical model

Introduction – Control systems – Control system configurations – Control system Terminology – Control system classes –Control system types, Differential equation of physical system, Mathematical modeling of Dynamic systems – Mechanical systems – Electrical systems– Fluid & Thermal system.

12 Hours

Unit II

System Representation

Introduction – Transfer function, Block Diagrams – Block Diagram Representation, zeros and poles– Block Diagram Reduction – Signal flow graphs – Signal flow graph algebra – Mason's Gain formula, Examples

12 Hours

Unit III

Feedback Characteristics of Control Systems

Feedback and non-feedback systems – Analysis of Feedback system, Controller types and actions – Stability of control systems – Routh-Hurwitz criterion – Steady state error, control of the effects of disturbance signals.

12 Hours

Unit IV

Time Response Analysis and Stability In Time Domain

Standard test signals - Time response of first and second order systems - Design specification for second order system - Design consideration for higher order system - Time response analysis for higher order systems. Concept of stability and necessary conditions, Routh stability criterion, relative stability analysis.

12 Hours

Unit V

Frequency Response Analysis and Frequency Domain

Introduction – Frequency Domain specifications, Bode analysis - Polar plot – Experimental determination of Transfer function - Nyquist stability criterion, closed loop frequency response, sensitivity analysis.

12 Hours

Total: 60 Hours

References

1. S. E. Lyshevski, *Control Systems Theory with Engineering Applications,* Springer-Verlag NewYork Inc,2002.
2. S.Norman Nise, *Control System Engineering*, John Wiley and Sons Inc., 6th edition, 2010.
3. I.J.Nagrath and M.Gopal ,*Control Systems Engineering*, New Age International Publishers, 2005.
4. K.Okata , *Modern Control Engineering*, Pearson/Prentice Hall of India Pvt. Ltd, New Delhi, 2009.
5. M. Gopal , *Control Systems – Principles and Design*, Tata McGraw Hill Co. Ltd., IInd edition 2006.
6. R.V.Dukkipati, *Engineering system Dynamics*, Narosa Publishing House, New Delhi, 2009.
7. S. H. Zak, *Systems and Control*, Oxford University Press Inc, 2003.
8. http://www.nptel.iitm.ac.in/video.php?subjectId=108102043
9. http://nptel.iitm.ac.in/courses/Webcourse-contents/IIT-Delhi/Control%20system%20design%20n%20principles/index.htm
10. http://utubersity.com/?page_id=901.

13ED22 / 13CC23 ADVANCED FINITE ELEMENT ANALYSIS

3 1 0 4

Course Objectives (COs):

- Provide further Advanced FEA knowledge and techniques for solving complex problems in engineering.
- Provide Knowledge to expertise in basic elements, Isoparametric elements – one and two dimensional problems, static & dynamic analysis in structural, heat transfer and fluid flow.

Course Learning Outcomes (CLOs):

1. Skill to select and use of finite elements for the different field problem like complex structure, heat transfer, vibration and fluid flow applications.

Programme Outcomes (PO):

(c) Ability to design a system or process to meet the desired needs and solving engineering problems

(f) Ability to solve open-ended engineering problems in Engineering Design areas including the design and realization of such systems

(i) Ability to identify engineering problems, and to carry out the engineering design of a system or component to meet desired needs, using modern tools for complex design.

Unit I
Introduction
Relevance of finite element analysis in design – Modeling and discretization, Interpolation, elements, nodes and Degrees-of-Freedom - Applications of FEA. One-Dimensional Elements and Computational Procedures: Bar element – Beam element– Assembly of elements – Properties of stiffness matrices - Boundary conditions - Solution of equations - Mechanical loads and stresses, Example problems.

12 Hours

Unit II
Basic Finite Elements
Interpolation polynomial approximation and Selection of the order of the polynomial, Convergence requirements, Linear, simplex, complex, Multiplex, Serendipity element and Higher order elements. Shape functions in terms of natural coordinate system – Constant Strain Triangular (CST) & Linear strain triangular elements(LST) - Bilinear rectangular elements - Quadratic Rectangular elements - Solid elements.

12 Hours

Unit III
Isoparametric Formulation
Introduction - Bilinear Isoparametric quadrilateral elements – shape function, Jacobian matrix, strain-displacement matrix, stress-strain relationship matrix, force vector. Numerical Integration - Static condensation– Load considerations– Stress calculations – Examples problems.

12 Hours

Unit IV
Dynamic Analysis
Dynamic equations – Consistent and lumped mass matrices - 1-D bar element - Formulation of element stiffness, mass and force matrices - Example problems. Natural frequencies - 1-D bar element - Formulation of element stiffness, mass matrices.

12 Hours

Fluid Flow, Shell and Plate Analysis
Fluid flow basic equation – 1-D fluid flow Finite element formulation - One dimensional fluid flow problems. Thin plate theory, Formulation of a Plate bending element stiffness matrix, Formulation of stiffness matrix for four noded degenarted quadrilateral shell element. Grid sensitivity test.

12 Hours
Total: 60 Hours

References

1. D. L.Logan, A First Course in the Finite Element Method, Thompson Learning, 2011.
2. S.S.Bhavikati, Finite Element Analysis, New Age International Publishers, 2004.
3. C.S.Krishnamoorthy, Applied Finite Element Analysis Theory and Programming, McGraw Hill,2011
4. S.S.Rao, The Finite Element Method in Engineering. Butterworth-Heinemann, 2011.
5. J. N.Reddy, An Introduction to the Finite Element Method, McGraw Hill International, 2006.
6. L. J.Segerlind, Applied Finite Element Analysis, John Wiley, 2004
7. http://www.mech.port.ac.uk/sdalby/mbm/CTFRProg.htm
8. http://www.me.mtu.edu/~bettig/MEEM4405

13ED23 / 13CC64 DESIGN OPTIMIZATION OF MECHANICAL SYSTEMS

3 1 0 4

Course Objectives (COs):

- To understand the formulation of a structural optimization problem, including defining appropriate design variables, constraints, and objective functions
- To apply various approximation methods to construct a sequence of approximate structural design problems appropriate for static strength, natural frequencies, buckling, and dynamic response
- To apply appropriate algorithms for discrete design variables and multi objective optimization problems

Course Learning Outcomes (CLOs):

1. Strengthen the analytical skills of the students
2. Able to apply the optimization techniques in various applications

Programme Outcomes (PO):

(c) Ability to design a system or process to meet the desired needs and solving engineering problems
(e) Ability to research concepts, simulate, test working conditions and application of modeling methods and their impact on the designed systems.
(i) Ability to identify engineering problems, and to carry out the engineering design of a system or component to meet desired needs, using modern tools for complex design.

Unit I
Introduction
Design Characteristics of Mechanical Elements - Adequate and Optimum design - Principles of optimization - Conventional Vs Optimal design process - Design variables - Formulation of objective function - Design constraints - Variable bounds - Classification of Engineering optimization problem**.**

12 Hours

Unit II
Single Variable Optimization Techniques
Optimality Criteria - Bracketing Methods - Exhaustive search method - Bounding phase method - Region Elimination Methods - Interval halving method - Fibonacci search method - Golden section search method - Gradient based Methods - Newton - Raphson method - Bisection method - Secant method - Cubic search method.

12 Hours

Unit III
Multi Variable and Constrained Optimization Techniques
Optimality criteria - Direct search Method - Simplex search methods - Hooke-Jeeve's pattern search method - Powell's conjugate direction method - Gradient based method - Cauchy's method - Newton's method - Conjugate gradient method. Kuhn - Tucker conditions - Penalty Function - Concept of Lagrangian multiplier - Complex search method - Random search method

12 Hours

Unit IV
Intelligent Optimization Techniques
Introduction to Intelligent Optimization - Soft Computing - Working principles of Genetic Algorithm Types of reproduction operators, crossover & mutation, - Simulated Annealing Algorithm - Particle Swarm Optimization (PSO) - Graph Grammer Approach - Example Problems

12 Hours

Unit V
Engineering Applications
Structural applications - Design of simple truss members. Design applications - Optimum design of simple axial, transverse loaded members - Optimum design of shafts - Optimum design of springs. Dynamic applications - Optimum design of single, two degree of freedom systems and gear vibration absorbers. Mechanisms applications - Optimum design of simple linkage mechanisms

12 Hours
Total: 60 Hours

References

1. Jasbir S Arora, *Introduction to Optimum design,* Mechrawhill International, 2011
2. S. S.Rao, *Engineering Optimisation: Theory and Practice*, Wiley- Interscience, 2008
3. K. Deb, *Optimization for Engineering design algorithms and Examples*, Prentice Hall of India Pvt. 2005
4. C.J. Ray, *Optimum Design of Mechanical Elements,* Wiley, John & Sons, 2007
5. R.Saravanan, *Manufacturing optimization through intelligent techniques*, Taylor & Francis Publications, CRC Press, 2006

13ED24 COMPUTER AIDED DESIGN ENGINEERING LABORATORY

0 0 3 2

Course Objectives (COs):

- To understand the types of element used, type of analysis done, interpretation of results, method of solving and analyzing a given problem
- To have better knowledge in finite element analysis software, applied to structural and heat transfer components at various loading conditions.

Course Learning Outcomes (CLOs):

1. Able to Select the method, meshing, analysis and optimise the given problem for structural, heat transfer and couple field applications.

Programme Outcomes (PO):

(a) Ability to work effectively in a team, exercise initiative, and function as a leader
(b) Ability to design and conduct experiments to analyze the data.
(e) Ability to research concepts, simulate, test working conditions and application of modeling methods and their impact on the designed systems.

List of Exercises

1. When a truss is subjected to certain temperature what happens to the truss? When another truss is loaded in all the three axis how will be its behavior?
2. When one end of a rigid body is hinged and other end loaded with two supports in between by a copper rod and a steel rod what will be the member forces and stresses.
3. Contemplate how the shear stress and bending stress will occur in a beam of I section which is simply supported at the ends and load acting at the center.
4. If a closed cylinder made of steel is subjected to an internal pressure how far the axial stress and hoop stress will influence the cylinder wall.
5. When a Belleville spring is subjected to a load on the inner edge of the spring how does the spring deflect?
6. Considering a culvert in which load is distributed uniformly at top, symmetric and assuming plain strain condition, come out with the maximum stress and deflection that occur in the culvert.
7. A Thermal storage device with a phase change material (PCM) is used to conserve energy during high energy demand periods. The PCM used is paraffin wax which is surrounded by a metallic pipe subjected to a constant temperature. Estimate the time required to completely melt the wax from its solid state.
8. When a solid stepped cantilever bar of circular cross section is subjected to a twisting moment how will be the maximum twist and shear stress?
9. Conduct a harmonic forced response test by applying a cyclic load (harmonic) at the end of a cantilever beam with load acting in a range of frequency. Suggest a suitable method in which maximum displacement occurs.
10. Perform various hardness testing methods for a given material and suggest a suitable method for the given load range?
11. Contemplate when a steady state conduction will be attained for a given component with the specified boundary condition.

Total: 45 Hours

13ED25 TECHNICAL SEMINAR

0 0 3 1

Course Objectives (COs):

• To develop journal paper reading and understanding skill.
• To improve communication and presentation skill of students

Course Learning Outcomes (CLOs):

1. Able to select the method, analysis and optimise the given problem for the given field applications.

Programme Outcomes (PO):

(g) Ability to solve open-ended engineering problems in manufacturing areas including the design and realization of such systems

The students are expected to make a presentation on the state of research on a particular topic based on current journal publications in that topic. A faculty guide is to be allotted and he / she will guide and monitor the progress of the student and maintain attendance also. Students are encouraged to use various teaching aids such as over head projectors, power point presentation and demonstrative models.

13ED51 APPLIED ELASTICITY AND PLASTICITY

3 0 0 3

Course Objectives (COs):

- To understand the theory of stress, strain and plasticity
- To enlighten the advances in plasticity and plastic strain analysis.

Course Learning Outcomes (CLOs):

1. Understand the stress and strain tensor field.
2. Understand the contact stresses analysis problem in bearing.
3. Understand advanced concepts of plasticity and plastic deformation analysis

Programme Outcomes (PO):

(d) Ability to identify potential changes in behavior and properties of materials as they are altered and influenced by manufacturing processes.
(e) Ability to research concepts, simulate, test working conditions and application of modeling methods and their impact on the designed systems.
(j) An understanding of contemporary issues and the ability to assess the impact of engineering solutions on the community.

Unit I
Analysis of stress and strain
Stress at a point, stress tensor, stress concentration factor, stress transformations, principal stresses, octahedral stress, equations of equilibrium, strain tensor, principal strains, strain-displacement relations, compatibility conditions, measurement of surface strains using strain gauges.

9 Hours

Unit II
Constitutive equations
General theory, generalized Hooke's law, equations of elasticity, formulation of the general elasticity problem, boundary conditions, two dimensional problems in rectangular and polar co-ordinates, Airy's stress function. Membrane stresses: Membrane stresses in axisymmetric shells, meridonial stress and circumferential stress.

9 Hours

Unit III
Contact stresses
Introduction, geometry of contact surfaces, notation and meaning of terms, expressions for principal stresses, method of computing contact stresses – Analytical and numerical method.

9 Hours

Unit IV
Plasticity
Plastic flow and its microscopic and macroscopic descriptions, stress-strain curves of real materials, definition of yield criterion, concept of a yield surface in principal stress space, yield criteria, tresca,von Mises, difference between tresca and von mises criteria.

9 Hours

Unit V
Plastic Strain Analysis
Prandtl-Reuss and Levy-Mises equations, deformation in plane stress-yielding of thin sheet in biaxial and uniaxial tension. Plane strain deformation-stress tensor, hydrostatic and deviatoric components, plastic potential, plastic instability, effect of strain rates and temperature effects on flow stress. Introduction to slip line theory, weighted residual method.

9 Hours
Total: 45 Hours

References

1. S P.Timoshenko and J. N. Goodier, *Theory of Elasticity*, McGraw Hill International Editions,2005.
2. F.William and Hosford, *Mechanical Behavior Materials*, Cambridge, 2005.
3. G E. Dieter, *Mechanical Metallurgy*, McGraw Hill, 2007.
4. B.Richard, Hetnarski, and Józef Ignaczak, *Mathematical Theory of Elasticity*, Taylor and Francis, 2004.
5. W. David , A. Rees, *Basic Engineering Plasticity*, Elsevier, 2006.
6. A P.Boresi , R J.Schmidt and O. M. Sidebottom , *Advanced Mechanics of Materials*, John Wiley and Sons, Inc., 2003.
7. L.S.Srinath, *Advanced mechanics of solid*, TataGraw Hill Education,Second reprint,2008
8. http://nptel.iitm.ac.in/video.php?courseId=1006

13ED52 / 13CC69 DESIGN OF HYDRAULIC AND PNEUMATIC SYSTEMS

3 0 0 3

Course Objectives (COs):

- To impart knowledge on fluid power engineering and power transmission systems,
- To create expertise in applications of fluid power systems in automation of machine tools and others equipment and to design hydraulic and electro-hydraulic systems for automation, pneumatic circuits using PLC, cascade, step counter and k-v mapping methods and to design low cost automation systems.

Course Learning Outcomes (CLOs):

1. Able to select the appropriate pump for a particular application in a circuit.
2. Designing various circuits used in the industries and Hydro pneumatic circuits.
3. Designing sequential circuits by using various methods.

Program Outcomes (PO):

(b) Ability to design and conduct experiments to analyze the data.
(c) Ability to design a system or process to meet the desired needs and solving engineering problems
(e) Ability to research concepts, simulate, test working conditions and application of modeling methods and their impact on the designed systems.

Unit I
Oil Hydraulic Systems and Hydraulic Actuators
Fluids – Properties - Types of Fluid power system - Hydraulic Power Generators – Selection and specification of pumps - Pump characteristics. Linear and Rotary Actuators – Selection - Specification and characteristics.

9 Hours

Unit II
Control and Regulation Elements
Direction Control Valves – Check valve, pilot operated check valve, Three-Way valves - Four – Way valves, Manually Actuated Valves, Mechanical Actuated Valves, pilot - Actuated Valves Solenoid - Actuated Valves - Shuttle Valves.Pressure Control Valves – Simple Pressure Relief Valves, Compound Pressure Relief Valves - Pressure - Reducing Valves - Unloading Valves - Sequence Valves, Counter Balance Valves - Flow Control Valves – Needle Valves - Non-Pressure - Compensated Valves. Pressure – Compensated Valves - Non-return and safety valves - Actuation systems.

9 Hours

Unit III
Hydraulic Circuits
Reciprocation - Quick return – Sequencing - Synchronizing Circuits - Accumulator circuits - Industrial circuits - Press circuits - Hydraulic milling machine – Grinding - Planning - Copying – Forklift - Earth mover circuits - Design and selection of components - Safety and emergency mandrels.

9 Hours

Unit IV
Pneumatic Systems and Circuits
Compressors –Principal –Types - Control elements, position and pressure sensing - Logic circuits - Switching circuits - Fringe conditions modules and these integration - Sequential circuits - Cascade methods - Mapping methods - Step counter method - Compound circuit design - Combination circuit design.

9 Hours

Unit V
Installation, Maintenance and Special Circuits
Pneumatic equipments- Selection of components - Design calculations – Application - Fault finding - Hydro pneumatic circuits - Use of microprocessors for sequencing - PLC, Low cost automation - Robotic circuits.

9 Hours
Total: 45 Hours

References

1. Antony Espossito, *Fluid Power with Applications*, Pearson education 2008
2. A.Dudley, Pease and J. J. Pippenger, *Basic fluid power*, Prentice Hall. 2010
3. Andrew Parr, *Hydraulic and Pneumatics (HB),* Jaico Publishing House 2004.
4. W.Bolton , *Pneumatic and Hydraulic Systems* , Butterworth –Heinemann 2006.
5. www.pneumatics .com
6. www.fluidpower.com.tw

13ED53 / 13CC67 DESIGN OF MATERIAL HANDLING EQUIPMENT

3 0 0 3

Course Objectives (COs):

- To impart knowledge on material handling facilities in a warehouse and the fundamental principles of material handling, material handling systems, and their limitations.
- To create awareness on the design concepts of all materials handling equipment.

Course Learning Outcomes (CLOs):

1. Ability to research concepts, simulate, test working conditions and application of modeling methods and their impact on the designed systems
2. Ability to identify engineering problems, and to carry out the engineering design of a system or component to meet desired needs, using modern tools for complex design

Programme Outcomes (PO):

(c) Ability to design a system or process to meet the desired needs and solving engineering problems
(d) Ability to identify potential changes in behavior and properties of materials as they are altered and influenced by manufacturing processes.

Unit I
Materials Handling Equipment
Introduction – Importance of material handling – Principle of material handling – Factors influences the choice of material handling - Material handling Equipments – Types - Selection and applications – Scope of material handling.

9 Hours

Unit II
Design of Hoists
Design of hoisting elements: Hemp and wire ropes - Design of ropes – Pulleys - Pulley systems - Sprockets and drums - Load handling attachments - Design of forged hooks and eye hooks - Brakes: shoe - Band and cone types.

9 Hours

Unit III
Drives of Hoisting Gear
Hand and power drives - Traveling gear - Rail traveling mechanism - Cantilever and monorail cranes – Slewing - Jib and luffing gear - Cogwheel drive - Selecting the motor ratings.

9 Hours

Unit IV
Conveyors
Types - Description - Design and applications of Belt conveyors - Apron conveyors and escalators - Pneumatic conveyors - Screw conveyors.

9 Hours

Unit V
Elevators
Bucket elevators: Design - Loading and bucket arrangements - Cage elevators - Shaft way – Guides - Counter weights - Hoisting machine - Design of form lift trucks.

9 Hours
Total: 45 Hours

References

1. Charles Reese, *Material handling Systems*, Taylor and Francis, 2005
2. Kari H.E.Kroemer, *Ergonomic Design of Material Handling Systems*,CRC Press USA, 2004.
3. Myer Kutz, *Environmental Conscious Materials Handling*, Wiley series In Environmentally Conscious Engineering, 2010.
4. R. B.Chowdary and G. R. N.Tagore ,*Material Handling Equiplments*, Khannn Publishers, 2003
5. M.Alexandrov, *Materials Handling Equipments*, MIR Publishers, 2002.
6. Kalaikathir Achchagam, *Design Data Book*, P.S.G. Tech, Coimbatore, 2012.

13ED54/13CC61 DESIGN OF THERMAL SYSTEMS

3 0 0 3

Course Objectives (COs):

- To create a wide knowledge on Constructional Details, Heat Transfer Flow Distribution,Stress Analysis,
- To impart knowledge on design of Heat Exchangers, Condensers and Evaporators

Course Learning Outcomes (CLOs):

- Understand the basic principles underlying piping, pumping, heat exchangers, modeling, and optimization in design of thermal systems
- Develop skills and techniques necessary to design of thermal systems
- Develop representative models of real processes and systems and draw optimizations concerning design of thermal systems

Programme Outcomes (PO):

(c) Ability to design a system or process to meet the desired needs and solving engineering problems
(e) Ability to research concepts, simulate, test working conditions and application of modeling methods and their impact on the designed systems.
(f) Ability to solve open-ended engineering problems in Engineering Design areas including the design and realization of such systems

Unit I
Introduction
Design Principles, workable systems, optimal systems, matching of system components, economic analysis, depreciation, gradient present worth factor.

9 Hours

Unit II
Mathematical Modeling
Equation fitting, nomography, empirical equation, regression analysis, different modes of mathematical models, selection, computer programmes for models.

9 Hours

Unit III
Design and Modeling of Thermal Equipments
Design and Modeling **-**Heat exchangers, evaporators, condensers, absorption and rectification columns, compressor, pumps, simulation studies, information flow diagram, solution procedures.

9 Hours

Unit IV
Systems Optimization
Objective function formulation, constraint equations, mathematical formulation, Calculus method, dynamic programming, geometric programming, linear programming methods, solution procedures.

9 Hours

Unit V
Dynamic behaviour of thermal system
Transient / un steady state simulation, Steady state simulation, laplace transformation, feedback control loops, stability analysis, nonlinearities.

9 Hours
Total: 45 Hours

References

1. J. N.Kapur ,*Mathematical Modeling*, Wiley Eastern Ltd., New York, 1994.
2. R. F. Boehm, *Developments in the Design of Thermal System*, Cambridge University Press, 2005.
3. Y.Jaluria, *Design and Optimization of Thermal Systems*, McGraw- Hill, 1998.
4. L. C.Burmeister, *Elements of Thermal-Fluid System Design*, Prentice Hall, 1998.
5. F.P. Incropera and D.P. Dewitt, *Introduction to Heat Transfer*, Wiley, 2001.
6. R.K.Shah and D.P.Sekulic, *Fundamentals of heat exchanger design*, john Wiley and Sons, Inc.,2003.

13ED55 / 13CC52 MECHATRONICS SYSTEM DESIGN

3 0 0 3

Course Objectives (COs) :

- To develop interdisciplinary knowledge on Electronics, Electrical, Mechanical and Computer Systems for the design of Mechanical and Electronic Systems.
- To impart the knowledge on microprocessors and their interfacing with mechanical systems.

Course Learning Outcomes (CLOs):

1. Students should be able to integrate electronics, mechanical devices, actuators, sensors, and computer control technologies appropriate for the building a mechatronic device.
2. Demonstrate how mechatronics integrates knowledge from different disciplines in order to realise engineering and consumer products that are useful in everyday life.

Programme Outcomes (PO):

(c) Ability to design a system or process to meet the desired needs and solving engineering problems

(e) Ability to research concepts, simulate, test working conditions and application of modeling methods and their impact on the designed systems.

(f) Ability to solve open-ended engineering problems in Engineering Design areas including the design and realization of such systems

Unit I
Introduction

Introduction to Mechatronics - Systems - Mechatronics in Products Mechatronics approach for design process, modeling of engineering systems, modeling system with spring, damper and mass, modeling chamber filled with fluid, modeling pneumatic actuator. Transfer functions, frequency response of systems, bode plot.

9 Hours

Unit II
Sensors and Transducers

Introduction - Performance Terminology - Displacement, Position and Proximity – Velocity and Motion - Fluid pressure - Temperature sensors - Light sensors - Selection of sensors – Signal processing - Servo systems. Memory-metal actuators, Shape memory alloys.

9 Hours

Unit III
Microprocessors in Mechatronics

Introduction - Architecture - Pin configuration - Instruction set - Programming of Microprocessors using 8085 instructions - Interfacing input and output devices - Interfacing D/A converters and A/D converters – Applications - Temperature control - Stepper motor control - Traffic light controller.

9 Hours

Unit IV
Automation System Design

Design of fluid power circuits – cascade, KV-map and step counter method. PLC – Basic structure -Input / Output processing – Programming of PLC. Sizing of components in pneumatic and hydraulic systems. Analysis of hydraulic circuits.

9 Hours

Unit V
Real Time Interfacing

Introduction to data acquisition and control systems, overview of I/O process, virtual Instrumentation, interfacing of various sensors and actuators with PC, Condition monitoring, SCADA systems. Traditional Mechatronics design - Designing - Possible design solutions – Case studies of Mechatronics systems.

9 Hours

Total: 45 Hours

References

1. M. B.Histand and G.D. Alciatore, *Introduction to Mechatronics and Measurement Systems,*McGraw - Hill International, 2007.
2. Devdas Shetty and Richard A Kolk, *Mechatronics System Design*, PWS Publishing Company,USA, 2006.
3. S.Ramesh, Gaonkar, *Microprocessor Architecture*, Programming and Applications Wiley Eastern, 2006.
4. W.Bolton , *Mechatronics*, Pearson Education Asia, New Delhi, 2007.
5. L. J.Kamm, *Understanding Electro-Mechanical Engineering*, *An Introduction to Mechatronics*, Prentice-Hall, 2003.
6. P. K.Ghosh and P R. Sridhar, *Introduction to Microprocessors for Engineers and Scientists* Prentice Hall, 2008.

13ED56 CAD/CAM

3 0 0 3

Course Objectives (COs):

- To understand the meaning of CAD/CAM and transfer of product data in various software
- To learn the concept and algorithms of visual realism so as to create a real rendered models in a software
- To appreciate the integration of CAD/CAM and to gain the advantage of lead time reduction

Course Learning Outcomes (CLOs):

1. Development of Algorithm for visual enhancement in CAD/CAM packages
2. Interfacing and Integration of CAD/CAM

Programme Outcomes (PO):

(c) Ability to design a system or process to meet the desired needs and solving engineering problems
(e) Ability to research concepts, simulate, test working conditions and application of modeling methods and their impact on the designed systems.
(g) The attitudes, abilities, and skills required to adapt to rapidly changing technologies and the ability to pursue life-long learning.

Unit I
Overview of CAD/CAM systems
CAD/CAM Hardware – Introduction - Types of systems – Evaluation criteria – Input Devices – Output devices – Hardware integration and networking – Hardware trends. Software – Graphics standards – User Interface – Software Modules – Modeling and Viewing – Software Documentation and Development – Software Trends.

9 Hours

Unit II
Three dimensional computer graphics
Viewing transformations – Orthographic and Perspective projection – Techniques for visual realism – Hidden line, Surface and curve removal – Algorithms for shading and Rendering.

9 Hours

Unit III
Data communications in CAD and CAM
Networking – Networking techniques, LAN - Components, wiring methods – Network interface cards – Network standards – Graphics standards – Data exchange format – Features of various interfaces JT file format, IGES, DXF, PDES, STEP – Collaborative Design

9 Hours

Unit IV
Computer aided process planning
Introduction to Process Planning and Production Planning – Process Planning in the Manufacturing cycle – Process Planning and Concurrent Engineering – Manual Approach, Computer Aided process planning(CAPP) – Variant, generative and Hybrid approaches – Group Technology.

9 Hours

Unit V
CAD/CAM integration
Introduction – Part production cycle – Manufacturing Systems – Manufacturing Processes – Integration Requirements – Part programming – Tool path generation and Verification – Design and Engineering Applications

9 Hours
Total: 45 Hours

References

1. Ibrahim Zeid, Sivasubramanian R, CAD/CAM theory and Practice, Tata McGraw Hill, 2011.
2. Groover, Mikell P Automation, Production system and Computer integrated Manufacturing, Prentice Hall of India Pvt. Ltd., 2008.
3. Kevin Otto and Kristin Wood, Product Design, Pearson Education, 2000
4. Aluvadeen A and Venkateshwaran N, Computer Integrated Manufacturing, Prentice Hall of India Pvt. Ltd., 2008
5. Ibrahim Zeid, Mastering CAD/CAM, Tata McGraw Hill, 2011.
6. Donald Hearn and M. Pauline Baker, Computer Graphics, Prentice Hall of India., New Delhi 2005
7. http://nptel.iitm.ac.in/courses/Webcourse-contents/IIT-Delhi/Computer Aided Design & Manufacturing

13ED57 / 13CC68 DESIGN AND MANUFACTURING OF COMPOSITE MATERIALS

3 0 0 3

Course Objectives (COs):

- To provide knowledge of simple stresses, strains and deformation due to external loads and their relations in orthotropic materials and their manufacturing.
- To impart knowledge on various smart materials and smart systems.

Course Learning Outcomes (CLOs):

1. Able to describe the properties of various available composite material.
2. Able to design the composite product suitable for specific applications.
3. Selection of suitable composite or smart materials for industrial oriented applications.

Program Outcomes (PO):

(b) Ability to design and conduct experiments to analyze the data.
(d) Ability to identify potential changes in behavior and properties of materials as they are altered and influenced by manufacturing processes.
(f) Ability to solve open-ended engineering problems in Engineering Design areas including the design and realization of such systems

Unit I
Introduction
Composite materials – Classification advantages and applications – Matrix –Types – Polymer – metal – Ceramics - properties and applications – Fibers –Characteristics - Manufacturing of Fibers – Glass – Carbon - Ceramic and Aramid fibers. Fiber Surface Treatments.

9 Hours

Unit II
Manufacturing Processes
Bag Moulding – Compression Moulding – Pultrusion – Filament Winding – Other Manufacturing Processes – Nonautoclave Curing - - Graphite Fiber Treatment - Manufacturing of metal matrix and ceramic matrix composites. - Quality Inspection methods.

9 Hours

Unit III
Mechanics and Performance
Characteristics of Fiber-reinforced Lamina – Laminates – Interlaminar stresses – Static Mechanical Properties – Fatigue and Impact Properties – Environmental effects – Reliability of Composites - Fracture Behavior and Damage Tolerance

9 Hours

Unit IV
Failure Analysis and Design
Failure Predictions – Failure Theories - Laminate Design Consideration - Classical lamination Theory - Analysis of Laminated Composite Beams – Plates - Shells Vibration and Stability Analysis – Finite Element Method of Analysis - Analysis of Sandwich structures

9 Hours

Unit V
Smart Materials
Shape memory alloys- Shape memory effect- Piezoelectric – ferroelectric and magnetostrictive materials – Magnetorheological fluids – Polymers in smart applications – Applications of smart materials in designing sensors, actuators and smart structures

9 Hours

References

1. P. K.Mallick, Fiber –*Reinforced Composites: Materials, Manufacturing and Design*, Maneel Dekker Inc, 2007.
2. J. C.Halpin, *Primer on Composite Materials, Analysis*, Techomic Publishing Co, 2006.
3. A. K. Kaw, *Mechanics of Composite Materials*, CRC Press, NY, 2006.
4. F. L.Matthews and R.D.Rawlings, *Composite Materials: Engineering and Sci*ence, Woodhead Publishing, 2005.
5. A.V.Srinivasan and Michael McFarland, *Smart Structures: Analysis and Design*, Cambridge University Press, UK, 2001.

13ED58 / 13CC71 RAPID PROTOTYPING AND TOOLING

3 0 0 3

Course Objectives (COs):

- To provide a exhaustive knowledge in RPT Tooling, with STL and DMLS Systems, FDM and LOM Process with applications, SGC and Printing Methods, LENS.
- To create expertise in the applications of RPT in component development

Course Learning Outcomes (CLOs):

1. Capability of creating two-dimensional and three-dimensional products and designs using appropriate tools, materials, methods and techniques
2. Increasing the skill of applying prototype model in various disciplines

Programme Outcomes (PO):

(c) Ability to design a system or process to meet the desired needs and solving engineering problems

(e) Ability to research concepts, simulate, test working conditions and application of modeling methods and their impact on the designed systems.

(f) Ability to solve open-ended engineering problems in Engineering Design areas including the design and realization of such systems

Unit I

Introduction

Need - Development of RP systems – RP process chain - Impact of Rapid Prototyping and Tooling on Product Development – Benefits- Applications- Classification of RP systems.

9 Hours

Unit II

STL and DMLS Systems

Stereo lithography systems – Principle – Process parameters – Process details – Machine details, applications. Direct Metal Laser Sintering (DMLS) system – Principle – Process parameters – Process details –machine details - Applications.

9 Hours

Unit III

FDM and LOM Process

Fusion Deposition Modeling – Principle – Process parameters – Process Details – Machine details - Applications. Laminated Object Manufacturing – Principle – Process parameters – Process details– Machine details-Applications.

9 Hours

Unit IV

SGC, 3D Printing and LENS methods

Solid Ground Curing – Principle – Process parameters – Process details – Machine details - Applications. 3-Dimensional printers – Principle – Process parameters – Process details – Machine details – Applications - Other concept modelers like thermo jet printers - Sander's model maker – JP system. Laser Engineering Net Shaping (LENS) - Ballistic Particle Manufacturing (BPM) – Principle and applications.

9 Hours

Unit V

Rapid Tooling and Applications of RPT

Introduction to rapid tooling – Direct and indirect method - Software for RP – STL files, Magics, Mimics. Application of Rapid prototyping in Medical field, manufacturing, automotive industries, aerospace and electronic industries.

9 Hours

Total: 45 Hours

References

1. D. T.Pham and S. S.Dimov, *Rapid manufacturing*, Springer-Verlag, London, 2001.
2. C. K.Chua , K. F.Leong and C. S.Lim, *Rapid prototyping: Principles and applications*, World Scientific Publishers, 2003.
3. Terry Wohlers, *Wohlers Report 2000*, Wohlers Associates, USA, 2000.
4. Andreas Gebhardt, Hanser , *Rapid prototyping*, Gardener Publications, 2003.
5. L.W.Liou, F.W. Liou, Rapid Prototyping and Engineering applications: A tool box for prototype development, CRC Press, 2007.
6. A. K. Kamrani, E. A. Nasr, *Rapid Prototyping: Theory and practice*, Springer, 2006.

13ED59 TRIZ FOR PRODUCT INNOVATION

3 0 0 3

Course Objectives (COs):

- To provide knowledge on product development technique through TRIZ.
- To expertise on the concept of TRIZ and ARIZ algorithms for design.

Course Learning Outcomes (CLOs):

- Capability of solving inventive or nonroutine technical problems within the framework of TRIZ

Programme Outcomes (PO):

(h) An understanding of all aspects of the design process including functional, creativity in the design of systems, processes and esthetic considerations
(i) Ability to identify engineering problems, and to carry out the engineering design of a system or component to meet desired needs, using modern tools for complex design.
(j) An understanding of contemporary issues and the ability to assess the impact of engineering solutions on the community.

Unit I
Introduction to TRIZ
Introduction to Product Innovation – Relationship between Invention and Innovation – Theories of Innovation: Breakthrough, incremental and open source. TRIZ – Theory to resolve Inventive Problems – TIPS – Theory of Inventive Problems Solving – Origin – Historical Development – About the Author – Genrich Altshuller – TRIZ Research for the improvement of Products, Processes, Systems and Services – Essence of TRIZ.

9 Hours

Unit II
Concept of TRIZ
Ideal final Result – Problem formulation and Functional analysis – Ideality – Contradiction; Physical and Technical – Resolving Contradiction – 39 Contradicting Parameters – Contradiction Matrix – Use of S Curve and Technology Evolution Trends; Statics, Kinematics and Dynamics – Case Studies

9 Hours

Unit III
Inventive principles and standard solutions
Definition of 40 Inventive Principles – Definition of 76 Standard Solutions – Improving the System with no or little change (13) – Improving the system by changing the system (23) – System Transitions (6) – Detection and Measurement (17) – strategies for simplification and improvement – Case Studies

9 Hours

Unit IV
ARIZ Algorithm
ARIZ – The Algorithm for Inventive Problem Solving – ARIZ frame work; Restructuring of the original problem – Removing the Physical Contradiction – Analysing the Solution – Macro flow Chart of ARIZ

9 Hours

Unit V
Case studies
Case Studies of Machine Tool – Automobile – Aircraft – Robotics. TRIZ and Quality – Synergy between QFD – Quality Function Deployment, Taguchi and TRIZ

9 Hours
Total: 45 Hours

References

1. 1.Semyon D and Savransky, *Engineering of Creativity - Introduction to TRIZ Methodology of Inventive Problem Solving*, CRC Press LLC, 2000
2. Fey V R and Rivin E I , *Innovation on Demand: New Product Development Using TRIZ*, Cambridge University Press 2005.
3. Genrich Altshuller , *TRIZ Keys to Technical Innovation*, Technical Innovation Center, 2002
4. Michael A orloff, *Inentive thinking through TRIZ , springer, 2012*
5. Genrich Altshuller translated by lev shulyak , *And Suddenly the Inventor Appeared TRIZ, the Theory of Inventive Problem Solving*, Technical Innovation Center, 1996
6. www.antitriz.orgss, www.triz-journal.com, www.aitriz.org, www.trizsite.com

13ED60 / 13CC65 TRIBOLOGY IN DESIGN

3 0 0 3

Course Objectives (COs):

- To impart knowledge on the theory of friction and wear, the principles involved in surface treatment, surface modifications, surface coatings for enhancing the life of a product based on its application.
- To create expertise on theory of lubricants physical properties and its standards, design and performance analysis of fluid film bearings, the kinematics, contact stress, bearing life capacity of rolling element bearing, Tribo Measurement, advances in Tribo-Instrumentation and standards of measurement.

Course Learning Outcomes (CLOs):

1. Able to apply in long life product development areas
2. Strengthen the skills in failure analysis and condition monitoring

Programme Outcomes (PO):

(c) Ability to design a system or process to meet the desired needs and solving engineering problems
(e) Ability to research concepts, simulate, test working conditions and application of modeling methods and their impact on the designed systems.
(i) Ability to identify engineering problems, and to carry out the engineering design of a system or component to meet desired needs, using modern tools for complex design.

Unit I
Surfaces, Friction and Wear
Topography of Surfaces – Surface features – Surface interaction – Theory of Friction – Adhesive theory of Sliding and Rolling Friction, Friction properties of metallic and non-metallic materials – Friction in extreme conditions – Thermal considerations in sliding friction. Wear, types of wear – Mechanism of wear – Wear resistance materials – friction control and wear prevention - surface modifications - transformation hardening, surface fusion – thermo chemical processes - surface coatings - fusion processes - vapour phase processes.

9 Hours

Unit II
Lubrication and Elasto Hydrodynamic Lubrication
Lubricants and their physical properties, lubricants standards – Additives and selection of Lubricants- Lubrication regimes, Hydrodynamic lubrication – Reynolds Equation – Thermal - Inertia and turbulent effects – Elasto hydrodynamic and plasto hydrodynamic theory-soft and hard EHL-Reynolds equation-film shape and thickness within and outside contact zones-Hydro static lubrication – Gas Lubrication

9 Hours

Unit III
Design of Fluid Film Bearings
Design and performance analysis of thrust and journal bearings – Full, partial, fixed and pivoted journal bearings design – Lubricant flow and delivery – Power loss, Heat and temperature rotating loads and dynamic loads in journal bearings – Special bearings – Hydrostatic Bearing design.

9 Hours

Unit IV
Selection of Rolling Element Bearings
Geometry and kinematics - Contact stresses – Hertzian stress equation-Spherical and Cylindrical contacts-Nominal life, static and dynamic capacity, equivalent load, probabilities of survival cubic mean load -Bearing mounting details, preloading of bearings.

9 Hours

Unit V
Seals
Different types -mechanical seals, lip seals, packed glands, soft piston seals, mechanical piston rod packing, labyrinth seals and throttling bushes, oil flinger rings and drain grooves -selection of mechanical seals.

9 Hours
Total: 45 Hours

References
1. B.Bhushan, *Principles and Application of Tribology,*John Wiley & sons, 2006.
2. A.Cameron, *Basic Lubrication Theory*, Ellis Hardwoods Ltd., UK, 2008.
3. S.K.Basu , S. N.Sengupatha and D. B.Ahuja, *Fundamentals of Tribology,* Prentice Hall of India Pvt. Ltd., 2009
4. J. A.Williams , *Engineering Tribology*, Oxford Univ. Press, 2007.
5. B. C. Majumdar, *Introduction to Tribology in bearings*, Wheeler Publishing, 2004.
6. I. M.Hutchings, *Tribology, Friction and Wear of Engineering Material*, Edward Arnold, London, 2005.
7. G. W. Stachowiak and A. W. Batchelor, *Engineering Tribology,* Butterworth-Heinemann publisher, 2005.
8. P. Sahoo ,*Engineering Tribology*, Prentice-Hall India, New Delhi, 2006**.**

13ED61 / 13CC51 INDUSTRIAL ROBOTICS

3 0 0 3

Course Objectives(COs):

- To impart the design concepts, parts and types of robots
- To create expertise in various drive systems of robot, sensors and their applications, programming, justification, implementation and safety of robot.

Course Learning Outcomes (CLOs):

1. Understand about robot kinematics and dynamics.
2. Ability to write basic program to control robot.
3. Understand about various sensors used in robotics field

Programme Outcomes (PO):

(g) The attitudes, abilities, and skills required to adapt to rapidly changing technologies and the ability to pursue life-long learning.
(h) An understanding of all aspects of the design process including functional, creativity in the design of systems, processes and esthetic considerations
(i) Ability to identify engineering problems, and to carry out the engineering design of a system or component to meet desired needs, using modern tools for complex design.

Unit I
Introduction and Robot Kinematics
Definition need and scope of Industrial robots – Robot anatomy – Work volume – Precision movement – End effectors – Sensors.
Robot Kinematics – Direct and inverse kinematics – Robot trajectories – Control of robot manipulators – Robot dynamics – Methods for orientation and location of objects. **9 Hours**

Unit II
Robot Control, Drives & End Effectors
Controlling the Robot motion – Position and velocity sensing devices – Design of drive systems –Hydraulic and Pneumatic drives – Linear and rotary actuators and control valves – Electro hydraulic servo valves – Electric drives – Motors – Designing of end effectors – Vacuum – Magnetic and air operated grippers.
9 Hours

Unit III
Robot Sensors
Sensors in Robot – Tactile sensor – Proximity and range sensors – Sensing joint forces – Robotic vision system – Machine vision - Image components - Representation - Hardware - Picture coding - Object recognition and categorizations - Software consideration.-Training of vision system
9 Hours

Unit IV
Work Cell Design and Applications
Robot work cell design and control – Safety in Robotics – Robot cell layouts – Multiple Robots and machine interference – Robot cycle time analysis - Industrial application - Material handling – Loading and unloading – Processing – Welding, Coating and Painting – Assembly and Inspection.
9 Hours

Unit V
Robot Programming, AI and Expert Systems
Methods of Robot Programming – Computer control and Robot Software - VAL system and Language - Artificial intelligence – Basics – Goals of artificial intelligence – AI techniques – Problem representation in AI Problem reduction and solution techniques - Application of AI and KBES in Robots.
9 Hours
Total: 45 Hours

References

1. Yoram Koren, *Robotics for Engineers,* Mc Graw-Hill, 2004.
2. K.S.Fu, R.C. Gonzalez and C.S.G. Lee, *Robotics Control Sensing, Vision and Intelligence*, TMH, 2003.
3. T.U.Kozyrey, *Industrial Robots*, MIR Publishers Moscow, 2002.
4. D.Richard, K. A. Thomas, Chmielewski and Michael Negin, *Robotics Engineering – An Integrated Approach*, Prentice-Hall of India Pvt. Ltd., 2001.
5. S. R.Deb, *Robotics Technology and Flexible Automation*, Tata Mc Graw-Hill, 2003.
6. http://www.robotics.com
7. http://nptel.iitm.ac.in/video.php?courseId=1052

13ED62 RELIABILITY ENGINEERING AND TOTAL PROTECTIVE MAINTENANCE

3 0 0 3

Course Objectives (COs):

- To impart knowledge about Reliability, Failure, Design of reliable system and Reliability testing.
- To learn how to Maintenance of electrical and Mechanical system
- To learn about Maintenance planning and Replacement decision.
- To impart knowledge about Total Protective Maintenance , CMMS, Reliability centered maintenance, and Reengineering maintenance

Course Learning Outcomes (CLOs)
1. Able to about Reliability and Failure.
2. Able to design parts/components for Reliability
3. Able to Maintenance of electrical and Mechanical system
4. Able to take Replacement decision.

Programme Outcomes (PO):

(c) Ability to design a system or process to meet the desired needs and solving engineering problems
(f) Ability to solve open-ended engineering problems in Engineering Design areas including the design and realization of such systems
(g) The attitudes, abilities, and skills required to adapt to rapidly changing technologies and the ability to pursue life-long learning.

Unit I
Reliability Engineering
Elements of Probability-Reliability Definition-Measures of Reliability- Factors affecting reliability -Failures-Classification of failures-Failure data Analysis-Availability-Criticality matrix- Event tree analysis-Utilization factor- Distribution of failure and repair times; determination of MTBF and MTTR, Reliability models; system reliability determination.

9 Hours

Unit II
Design for Reliability
Analysis of reliability data-Weibull analysis-Design and manufacture for Reliability-Reliability of parts and components-Design for system reliability- Economics of standby or redundancy in production system-reliability testing-Types

9 Hours

Unit III
Fundamentals of Maintenance
Objectives and functions of Maintenance- Maintenance strategies- Maintenance types, work standards, logistic support, organization for maintenance. Maintenance of electrical, mechanical drives & systems, standard. Maintenance practice & procedures, machine diagnostics, machine condition monitoring and signature analysis. Cost of maintenance

9 Hours

Unit IV
Maintenance planning and replacement decision
Overhaul and repair- meaning and difference- Optimal Overhaul- Repair policies for equipment subject to breakdown. Optimal interval between preventive replacement of equipment subject to break down, group replacement

9 Hours

UNIT V
Modern Maintenance concepts
Reliability Centered Maintenance - Total Productive Maintenance - philosophy and implementation- Signature ANALYSIS- CMMS- Concept of tero-technology- Reengineering Maintenance process

9 Hours
Total: 45 Hours

References

1. R. C.Mishra and K.Pathak , *Maintenance Engineering and Management*, PHI, 2005.
2. Sushil Kumar Srivatsava, *Industrial Maintenance Management*, S Chand and Company, 2005.
3. A.K.Jardine, *Maintenance, Replacement and Reliability*, Pitman Publishing, 2003.
4. Kelly and M J. Harris, *Management of Industrial Maintenance*, Butter worth and Company Limited, 2001.

13ED63 / 13CC53 ADVANCED TOOL DESIGN

3 0 0 3

Course Objectives (COs):

- To impart knowledge on Tool design and advanced cutting tool materials.
- To develop skill on design of cutting tools, forming tools and jigs
- To create expertise in press tool design and fixtures for CNC machines

Course Learning Outcomes (CLOs):

1. Develop the knowledge about cutting tools
2. Able to design Jigs & fixtures, Dies & Press tools for conventional & CNC machines

Programme Outcomes (PO):

(c) Ability to design a system or process to meet the desired needs and solving engineering problems
(i) Ability to identify engineering problems, and to carry out the engineering design of a system or component to meet desired needs, using modern tools for complex design.
(j) An understanding of contemporary issues and the ability to assess the impact of engineering solutions on the community.

Unit I
Designing of cutting tools
Stereometry of cutting tools - Orthogonal and oblique cutting - Derivation of equation of forces – Shear plane angle - Merchants theory. Heat development in machining - Effects of various parameters - Measurement methods to determine Chip tool interface temperatures - Action of cutting fluids – Failure of cutting tools - Plastic failure - Brittle fracture – Wear- Mach inability

9 Hours

Unit II
Design of Jigs and Fixtures
Principles of Jigs and Fixtures design - Locating principles - Locating elements - Standard parts - Clamping devices - Drill bushes-Different types of Jigs-Plate latch – Channel – Box – Post – Angle plate - Angular post – Turnover - Pot jigs- Automatic drill jigs - Rack & Pinion Operated – Air operated Jigs Components - Fixtures - General principles of boring – Lathe - milling and broaching fixtures – Grinding - Planing and shaping fixtures – Assembly - Inspection and Welding fixtures - Modular fixtures - Design and development of Jigs and fixtures for given components

9 Hours

Unit III
Design of Molding Dies
Plastic materials, shrinkage, two and three plate mold design, standard mold plates, parting line, core and cavity generation in CAD, runner and gate design, mold cooling, ejection methods, tool materials, runner less molds, microstructure injection molding for MEMs, multi color injection molding, mold flow analysis using CAE, introduction to thermo setting dies, texturing

9 Hours

Unit IV
Design of Press Tools
Press working terminology - Presses and Press accessories - Computation of capacities and tonnage requirements - Strip layout-Design and development of various types of cutting - Forming and drawing dies - Blank development for Cylindrical and non cylindrical shells - Compound progressive - Combination dies

9 Hours

Unit V
Tool Design for CNC Machine Tools
Introduction –Tooling requirements for Numerical control systems – Fixture design for CNC machine tools-Sub plate and tombstone fixtures-Universal fixtures– Cutting tools– Tool holding methods– Automatic tool changers and tool position – Tool presetting– General explanation of the Brown and Sharp machine

9 Hours
Total: 45 Hours

References
1. C. Donaldson, G. H.Lecain and V. C.Goold , *Tool Design*, Tata McGraw- Hill, 2007
2. Bhattacharya, *Metal Cutting Theory and Practice* , New Central Book Publishers, Calcutta,2003.
3. B. L.Juneja and G S.Sekhon, *Fundamentals of Metal cutting and Machine tools*, New Age International (P) Ltd., New Delhi, 2005.
4. R.A.Lindberg, *Process and Materials of Manufacture*, Prentice-Hall of India Pvt.Ltd, New Delhi, 2004.
5. S. F.Krar and F. A. Check, *Technology of Machine Tools*, Tata McGraw-Hill international, 2003.
6. R. C. Wpye, *Injection Mold Design*, East West Press, 2004.

13ED64 DESIGN OF MECHANICAL DRIVES

3 0 0 3

Course Objectives (COs):

- To impart knowledge on power transmission systems and various drives.
- To develop design knowledge on speed drives, feed drives and friction drives.

Course Learning Outcomes (CLOs):

1. To understand the basic geometrical specifications of various machine component with their functional and strength requirements.
2. To understand the procedures and standards for designing various machine components with maximum economy and efficiency

Programme Outcomes (PO):

(c) Ability to design a system or process to meet the desired needs and solving engineering problems

(e) Ability to research concepts, simulate, test working conditions and application of modeling methods and their impact on the designed systems.

(f) Ability to solve open-ended engineering problems in Engineering Design areas including the design and realization of such systems

Unit I
Introduction
Power Transmission systems: General considerations, principal types, comparative study of different drives, applications and limitations.

9 Hours

Unit II
Design of speed drives
Principles of gear tooth action, gear geometry. Analysis and design of spur, helical, bevel and worm gearing - working stresses - bearing loads - shear stresses and power losses in gear drives - Modes of gear failure and remedial measures.

9 Hours

Unit III
Design of feed drives
Requirements, types, feed drive using feed boxes, design of power screws, lead screws, selection of recirculation ball screws, LM guide ways, rotary indexing drives, applications, feeding mechanisms in automated plants, pneumatic feed units, Principles

9 Hours

Unit VI
Design of friction drives
Partial friction drives, couplings, clutches, toothed clutches, unidirectional clutches, safety clutches, drum, disk brakes, design principles

9 Hours

Unit V
Variable speed drives
Need, different types, applications. Design of feeding mechanisms for automation, Design of headstock, Design of cam drive for automate, Selection of timing belt for a CNC machine

9 Hours
Total: 45 Hours

References

1. J.E. Shigley, Mechanical Engineering Design, McGraw Hill, 2006.
2. HMT, Mechatronics, Tata McGraw Hill, 2008.
3. G M.Maitra, Hand Book of Gear Design, Tata McGraw Hill, 2008.
4. Faculty of Mechanical Engineering, PSG College of Technology, Design Data Book , DPV Printers, 2003.
5. N.Reshetov, Machine Design, MIR Publishers, 1995.
6. N. K.Mehta, Machine tool Design and Numerical Control, TMH 2008.

13ED65 ROTOR DYNAMICS

3 0 0 3

Course Objectives (COs):

- To develop expertise regarding rotor dynamics and vibration in rotating machinery.
- To expose to rigid rotor dynamics, rotor vibration and critical speeds.

Course Learning Outcomes (CLOs):

1. Development of skill to analyze vibration in rotating machinery.
2. Acquires knowledge in balancing and condition monitoring of rotors.

Programme Outcomes (PO):

(d) Ability to identify potential changes in behavior and properties of materials as they are altered and influenced by manufacturing processes.
(e) Ability to research concepts, simulate, test working conditions and application of modeling methods and their impact on the designed systems.
(f) Ability to solve open-ended engineering problems in Engineering Design areas including the design and realization of such systems

Unit I
Introduction to Vibration and the Laval-Jeffcott Rotor Model
Co-ordinate systems, steady state rotor motion, elliptical motion, single degree of freedom systems, free and forced vibrations. The two degrees of freedom rotor system, translational motion, natural frequencies and natural modes, steady state response to unbalance, the effect of flexible support.

9 Hours

Unit II
Torsional Vibration in Rotating Machinery
Modeling of rotating machinery shafting - Multi degree of freedom systems - Determination of natural frequencies and mode shapes - Branched systems - Holzer method.

9 Hours

Unit III
Rigid Rotor Dynamics and Critical Speeds
Rigid disk equation - Rigid rotor dynamics- Rigid rotor on flexible rotor - The gyroscopic effect on rotor dynamics - Whirling of an unbalanced simple elastic rotor, simple shafts with several disks - Effect of axial stiffness - Determination of bending critical speeds - Campbell diagram.

9 Hours

Unit IV
Influence of Bearing on Rotor Vibration
Support stiffness on critical speeds- Stiffness and damping coefficients of journal bearings-computation and measurements of journal bearing coefficients -Mechanics of Hydro dynamic Instability- Half frequency whirl and Resonance whip- Design configurations of stable journal bearings

9 Hours

Unit V
Balancing and Condition Monitoring of Rotors
Single plane balancing, multi-plane balancing, balancing of rigid rotors, balancing of flexible rotors Noise spectrum, real time analysis, knowledge based expert systems.

9 Hours
Total: 45 Hours

References

1. J. S.Rao, *Rotor Dynamics*, New Age International Publishers, New Delhi, 2004.
2. S.Timoshenko, D H.Young and W. Weaver , *Vibration Problems in Engineering*, John Wiley,2000.
3. Weng Jeng Chen and J Edger Gunter, *Introduction to Dynamics of Rotor – Bearing Systems*, Trafford Publishing Ltd., London 2007.
4. T. Yamamoto and Y.Ishida , *Linear and Nonlinear Rotordynamics: A Modern Treatment with Applications*, John Wiley and Sons Inc, New York, 2001.
5. J. S.Rao, *Vibratory Condition Monitoring of Machines*, Narosa Pubulishing House, 2000.

13ED66 NANOMATERIALS AND NANOTECHNOLOGY

3 0 0 3

Course Objectives (COs):

- To impart knowledge on the general issues relating to nanotechnology and nanofabrication.
- Methods for production of Nanoparticles and Characteristic techniques of nanomaterials

Course Learning Outcomes (CLOs):

1. Students will acquire the knowledge of the representatives of Nano particles and Characteristic techniques of nano materials.
2. To make students familiar with new trends in engineering, namely nanotechnology and nanofabrication and with their applications in modern industries.
3. By the end of this course, students will be able to get the knowledge in the field of nanotechnology and nano materials.

Programme Outcomes (PO):

(d) Ability to identify potential changes in behavior and properties of materials as they are altered and influenced by manufacturing processes.

(e) Ability to research concepts, simulate, test working conditions and application of modeling methods and their impact on the designed systems.

(i) Ability to identify engineering problems, and to carry out the engineering design of a system or component to meet desired needs, using modern tools for complex design.

Unit I
Zero – Dimensional Nanostructures
Nanoparticles through homogenous nucleation, nanoparticles through the heterogeneous nucleation, kinetically confined synthesis of nanoparticles, epitaxial core – shell nanoparticles. One Dimensional Nanostructure-Nanowires And Nanorods: Spontaneous growth, template based synthesis, electro spinning, and lithography.

9 Hours

Unit II
Two-Dimensional Nanostructures-Thin Films
Fundamentals of film growth, vacuum science, physical vapor deposition (PVD), Chemical Vapor Deposition(CVD), Atomic Layer Deposition (ALD), Electrochemical Deposition, Sol-Gel films.

9 Hours

Unit III
Nanostructures Fabricaiton
Lithography, nano manipulation and nanolithography, soft lithography, assembly of nanoparticels and nanowires, other methods of micro fabrication, Scanning Electron Microscope. Nanomechanics: A high speed review of motion: Displacement, velocity, acceleration and force, nano mechanical oscillation, feeling faint forces.

9 Hours

Unit IV
Nano Electronics: Electron Energy Bands, Electrons In Solids
Conductors, insulation and semi conductors, fermi energy, the density of states for solids, quantum confinement, tunneling, single electron phenomenon, molecular electronics. Nanophotonics: Photonics properties of nanomaterials, near-field light, optical tweezers, photonic crystals.

9 Hours

Unit V
Nano scale heat transfer
Nanoscale heat, conduction, convection, radiation. Nanoscale Fluid Mechanics: Fluids at the nanoscale: major concepts, flow fluids flow at the nanoscale, applications of nanofludics

9 Hours
Total: 45 Hours

References

1. Ben Rogers, Pennathur and Adams, *Nanotechnology: Understanding Small System*, CRC Press, 2008.
2. Bhushan, Bharat *(Ed.) Handbook of Nanotechnology*, Springer 2006.
3. Guozhong Cao, *Nanostructures and Nanomaterials*, Imperial College Press, 2006.
4. Yury Gogotsi, *Nanomaterials Handbook*, Drexel University, Philadelphia, Pennsylvania, USA, 2006.
5. Lundstrom, Mark, Guo, Jing, *Nanoscale transistors, Device physics*, *modeling and simulation*, Springer,2006.
6. Chunli Bai, Sishen Xie, Xing Zhu, *Nanoscience and Technology, part 2,* Technology and Engineering, 2007.
7. A.V. Narlikar, Y.Y. Fu, Oxford Handbook of Nanoscience and Technology, Volumes 1, 2, 3, the Complete Set Publication Date: March 2010
8. S.M. Lindsay, Introduction to Nanoscience, Hardback-Nov 2009 or Paperback-Dec 2009.
9. V.S. Muralidharan, A. Subramania, Alagappa Chettiar College of Engineering and Technology, Ind, November 20, 2008.

13ED67 MICRO ELECTRO MECHANICAL SYSTEMS DESIGN

3 0 0 3

Course Objectives (COs):

- To get an exposure on the application of MEMS in various domains
- To impart knowledge on MEMS with their manufacturing techniques
- To create exposure to packaging techniques of MEMS
- Make students to scale up and scale down the physical quantities of micro system

Course Learning Outcomes (CLOs):

1. Adequate to use the desired products in complex environments
2. Identify the materials based on its application
3. Choosing the suitable fabrication technique

Program Outcomes (POs):

(c) Ability to design a system or process to meet the desired needs and solving engineering problems

(d) Ability to identify potential changes in behavior and properties of materials as they are altered and influenced by manufacturing processes.

(e) Ability to research concepts, simulate, test working conditions and application of modeling methods and their impact on the designed systems.

Unit I

Introduction

Introduction to MEMS and Microsystems, typical products, Microsystems and micro electronics – applications of Microsystems in automobile and other industries, working principle of Microsystems – types of micro sensors, Micro actuation techniques —MEMS with micro actuators – micro pump – micro motors – micro valves – micro grippers – micro accelerometers, micro fluids. MEMS gyroscope, Electrostatic fluid accelerator

9 Hours

Unit II

Materials for MEMS and Microsystems

Substrates and wafer – active substrate materials, silicon as a substrate material, silicon compounds- silicon dioxide, silicon carbide, silicon nitride, polycrystalline silicon, silicon piezo-resistors,– - Gallium arsenide, quartz, - piezoelectric crystals – polymers as industrial materials, polymers for MEMS and Microsystems, conductive polymers – Langmuir-Blodgett films, packing materials. Glass, Tungsten film and Sillimanite

9 Hours

Unit III

Fabrication Processes

Photolithography – photoresists and application, light sources, phoresist development, removal and postbacking, Ion implantation, diffusion, oxidation process, chemical vapor deposition-working principle, chemical reactions, rate of deposition, physical vapor deposition –sputtering, deposition by epitaxy, etching- chemical etching and plasma etching. Electron beam lithiography and HF etching

9 Hours

Unit IV

Micromanufacturing

Bulk micromanufacturing- etching, isotropic and anisotrotpic etching, wet and dry etching, surface micro machining, – LIGA process- general description materials, electroplating, SLIGA process, Process design-photolithography, thin film fabrication, geometry shaping. Micro cutting and Chemical mechanical planarization

9 Hours

Unit V

Microsystem Packaging

Mechanical packaging of microelectronics, Micro system packaging – general considerations, three levels of packaging-die level, device level and system level, interfaces in microsystem packaging, essential packaging technologies, three dimensional packaging, assembly of Microsystems, selection of packaging materials, signal mapping and transduction. Zero level packaging

9 Hours

Total: 45 Hours

References

1. Tai- Ran Hsu, *MEMS & Microsystems Design and Manufacture*, TMH, education, 2010.
2. N.P.Mahalik, *MEMS*, McGraw-Hill Companies, 2010
3. Gardner, W.Julian, K. Varadan Vijay and O.Awadelkarim, Osama, *Micro sensors MEMS and Smart Devices*, Jhon Wiley & Sons Ltd, 2001.
4. Gad-el-Hak, Mhamed, *The MEMS Handbook*, CRC Press 2002.
5. S.Fatikow, U.Rembold, *Microsystem Technology and Microrobotics*, Springer–Verlag, Berlin, Heidelberg, 1997.
6. E.H. Tay, Francis and W.O.Choong , *Micrfluids and Bio MEMS applications,* Springer, 2002.
7. www.memx.com
8. www.memsnet.org

13ED68 FAILURE ANALYSIS AND DESIGN

3 0 0 3

Course Objectives (COs):

- To impart knowledge about various modes of failure this leads to safe design.
- To expose to fracture mechanics and failure analysis tools.

Course Learning Outcomes (CLOs):

1. Understanding about material selection process and fracture behaviour of different materials.
2. Ability to select materials for different engineering applications based on various criteria.
3. Acquires knowledge about failure analysis tools.

Programme Outcomes (PO):

(d) Ability to identify potential changes in behavior and properties of materials as they are altered and influenced by manufacturing processes.

(e) Ability to research concepts, simulate, test working conditions and application of modeling methods and their impact on the designed systems.

(f) Ability to solve open-ended engineering problems in design engineering areas including the design and realization of such systems.

Unit I
Materials and Design Process
Factors affecting the behavior of materials in components, effect of component geometry and shape factors, design for static strength, stiffness, designing with high strength and low toughness materials, material selection process, introduction to stress, two dimensional and three dimensional state of stress, Mohr's circle two and three dimensions, hydrostatic stress, Von-mises, maximum shear stress (Tresca), octahedral shear stress, torsional stresses for large plastic strain.

9 Hours

Unit II
Fracture Mechanics
Ductile fracture, brittle fracture, cleavage-fractography, ductile-brittle transition, fracture mechanics approach to design-energy criterion, stress intensity approach, time dependent crack growth and damage - Linear Elastic Fracture Mechanics: Griffith theory, energy release rate, Instability and R-curve, stress analysis of cracks-stress intensity factor, K-threshold, Crack growth instability analysis, crack tip stress analysis.

9 Hours

Unit III
Fatigue
Statistical nature of fatigue, S-N curve, low cycle fatigue, strain life equations, structural feature of fatigue, fatigue crack propagation, effect of stress concentration, size, surface properties, metallurgical variables on fatigue, case studies, designing against fatigue, detail design, improvements after failure and service, fatigue of bolts, welded and adhesive joints. Fatigue Tests**-** Purpose, specimen, fatigue test procedures, evaluation of fatigue test results, crack growth measurement. Creep, stress rupture, elevated temperature fatigue, metallurgical instabilities.

9 Hours

Unit IV
Corrosion and Wear Failures
Types of corrosion, Factors influencing corrosion failures, analysis of corrosion failures, stress corrosion cracking - sources, characteristics of stress corrosion cracking, procedure of analysing stress corrosion cracking, various types of hydrogen damage failures, corrective and preventive action. Types of wear, lubricated and non – lubricated wear, wear on different materials, different methods of wear measurement. Role of friction on wear, analysis of wear failures, wear tests -SOAP, ferrography.

9 Hours

Unit V
Failure Analysis Tools
Reliability concept and hazard function, life prediction, life extension, application of poisson, exponential and Weibull distribution for reliability, bath tub curve, parallel and series system, MTBF,MTTR, FMEA definition-Design FMEA, process FMEA, analysis causes of failure, modes, ranks of failure modes, fault tree analysis, industrial case studies / Projects on FMEA.

9 Hours
Total: 45 Hours

References

1. T L.Anderson , *Fracture Mechanics: Fundamentals and Applications*, CRC Press 2005.
2. F.Michael and Ashby, *Material Selection in Mechanical Design*, Butterworth Heinemann, 1999.
3. ASM Metals Handbook, *Failure Analysis and Prevention*, ASM Metals Park, Ohio, USA, Vol. 10, 2002
4. J.E. Shigley and Mische, *Mechanical Engineering Design*, *McGraw Hill, 1992. Preshant Kumar*, *Elements of Fracture Mechanics*, Wheeler Publishing, 1999.
5. M.John, Barsoom and S.T. Rolte, *Fracture and Fatigue Control in Structures*, Prentice Hall, 1987.

13ED69 GEOMETRIC MODELLING

3 0 0 3

Course Objectives (COs):

- To develop the modeling techniques for curves, surfaces and solids.
- To impart knowledge on visual realism and computer animation

Course Learning Outcomes (CLOs):

1. Understand the methods of representation of wireframe, surface, and solid modeling systems.
2. Understand advanced concepts of feature based modeling and parametric modeling.

Programme Outcomes (PO):

(c) Ability to design a system, component, or process to meet desired needs and solve engineering problems.

e) Ability to research concepts, simulate, test working conditions and application of modeling methods and their impact on the designed systems.

Unit I
Overview of CAD Systems and Graphics Transformations:
Conventional and computer aided design processes, subsystems of CAD-CAD hardware and software, analytical and graphics packages, CAD workstations. Networking of CAD systems, generative, cognitive and image processing graphics, static and dynamic data graphics. Transport of graphics data. Graphic standards, generation of graphic primitives, display and viewing, transformations customizing graphics software.

9 Hours

Unit II
Mathematical Representation of Curves and Surfaces:
Introduction, Wireframe models, parametric representation of curves (analytic and synthetic), curve manipulation, surface models, types of surfaces, introduction to parametric representation of surfaces, design examples.

9 Hours

Unit III
Mathematical Representation of Solids:
Fundamentals of solid modeling, boundary representation, constructive solid geometry, solid manipulations, solid modeling based applications.

9 Hours

Unit IV
Visual Realism and Computer Animation:
Model cleanup, hidden line removal, shading, computer animation, animation systems, design applications.

9 Hours

Unit V
Mass Property Calculations
Introduction, geometrical property formulation, mass property formulation, design and engineering applications.

9 Hours
Total: 45 Hours

References

1. Ibrahim Zeid, *CAD/CAM Theory and Practice*, McGraw Hill Inc., New Delhi, 2005.
2. P.Radhakrishnan and C.P. Kothandaraman, *Computer Graphics and Design*, Dhanpat Rai and Sons, 1999.
3. P.Radhakrishnan and S. Subramanyan , *CAD/CAM/CIM*, Wiley Eastern Limited, 2003.
4. E.Michael Mortenson, *Geometric Modeling*, John Wiley and Sons Inc, 2008.
5. V. B. Anand, *Computer Graphics and Geometric Modeling for Engineers*, John Wiley and Sons Inc, New Delhi, 2009.
6. D. Solomon, *Computer Graphics and Geometric Modeling*, Springer Verlag, 2006.

13ED70 / 13CC60 DESIGN OF AUTOMOTIVE SYSTEMS

3 0 0 3

Course Objectives (COs) :

- To have a deep knowledge of the automotive product in terms, of architecture and performance.
- To know the different steps and the methodology to design a braking system ,suspension system and other sub components..
- To have a large technological knowledge in these domains.
- To know how to simulate the dynamic behavior of a vehicle.

Course Learning Outcomes (CLOs):

1. The ability to contribute and function in a collaborative environment.
2. The ability to identify, analyze and solve technical problems in the automobile field.
3. An ability to utilize and apply critical thinking skills for better employability.

Programme Outcomes (PO):

(e) Ability to research concepts, simulate, test working conditions and application of modeling methods and their impact on the designed systems.

(f) Ability to solve open-ended engineering problems in design engineering areas including the design and realization of such systems.

(h) An understanding of all aspects of the design process including functional, creativity in the design of systems, components or processes and esthetic considerations.

Unit I
Introduction
Fundamentals of designing automobiles, general layout of the automobile, types of chassis layout, various types of frames, constructional details, materials, unitized frame body construction.

9 Hours

Unit II
Design of Engine Components
Choice of material for various engine components, design of cylinder, design of piston assembly, design of connecting rod, design of crankshaft under bending and twisting, balancing weight calculations, design of valves, valve springs and design of flywheel.

9 Hours

Unit III
Design of Clutch & Brakes
CLUTCHES: Introduction-design diagrams of clutch, calculation of critical parameters of clutches, design calculation of standard elements of friction clutches.
BRAKES: Pressure distribution along shoe length, determining braking torque, design of drum brakes-internally expanding brakes, design of disc brakes.

9 Hours

Unit IV
Design of Transmission Systems
Determining main parameters of transmission, differential, axle shafts, gear box, design of universal joint and propeller shaft, location determination of universal joint and propeller shaft.

9 Hours

Unit V
Suspension and Steering System
Oscillation and smoothness of ride, fundamentals of designing and calculating steering control linkage, steering gears, hydraulic booster.
Automotive Electronics
Sensors in automobiles, engine management system

9 Hours
Total: 45 Hours

References

1. Lukin P Gasparyants G and Rodionov V, “Automobile Chassis Design and Calculations”, Mir Publishers, Moscow, 2005.
2. Heinz Heisier, “Vehicle and Engine Technology”, SAE, New York, 2007.
3. Gillespie T D, “Fundamentals of Vehicle Dynamics”, SAE Inc., New York, 2006.
4. Schwaller A E, “Motor Automotive Technology”, Third Edition, Delman Publishers, New York, 2008.
5. Steed W - “Mechanics of Road Vehicles”- Illiffe Books Ltd., London- 2005.
6. Giles J G, “Steering, Suspension and Tyres”, Iiiffe Book Co., London- 2004.
7. Julian Happian and Smith**,** **“**An Introduction to Modern Vehicle Design”, Butterworth-Heinemann, A division of reed educational and professional publishers ltd, 2001

13ED71 / 13CC72 COMPUTATIONAL FLUID DYNAMICS

3 0 0 3

Course Objectives (COs):

- To create expertise in simulation used for engineering applications.
- Ability to design a system or process to meet desired needs and solve engineering applications.

Course Learning Outcomes (CLOs):

1. Understanding about compressible and incompressible flow fluids
2. Ability to select the governing equations for conduction and convection fluid flow applications.
3. Acquires knowledge about grid generation, processing and applications of CFD.

Programme Outcomes (PO):

(c) Ability to design a system, component, or process to meet desired needs and solve engineering problems.

(e) Ability to research concepts, simulate, test working conditions and application of modeling methods and their impact on the designed systems.

(f) Ability to solve open-ended engineering problems in design engineering areas including the design and realization of such systems.

Unit I
Introduction
Impact and applications of CFD in diverse fields - governing equations of fluid dynamics- continuity – momentum and energy - generic integral form for governing equations - Initial and Boundary conditions - Classification of partial differential equations- Hyperbolic, Parabolic, Elliptic and Mixed types - Applications and Relevance.

9 Hours

Unit II
Basic Aspects of Discretization
Discretization techniques- Finite difference, Finite volume and Finite element method- Comparison of discretization by the three methods. Introduction to Finite differences, Difference equations, Uniform and non-uniform grids, numerical errors, Grid independence test and Optimum step size.

9 Hours

Unit III
Grid Generation
Transformation of non-uniform grids to uniform grids, General transformation of the equations – Form of the governing equations suitable for CFD - Compressed grids, Boundary fitted co-ordinate systems- Elliptic grid generation - Adaptive grids - Modern developments in grid generation.

9 Hours

Unit IV
Conduction and Convection
Steady One dimensional conduction- two and three-dimensional conduction- Steady one-dimensional convection and Diffusion -Transient one-dimensional and two-dimensional conduction- Explicit, Implicit, Crank-Nicolson, ADI scheme-Stability criterion.

9 Hours

Unit V
Incompressible Fluid Flow and Applications of CFD
Gradient term and continuity equation- Staggered grid- Momentum equations-Pressure and velocity corrections-Pressure Correction equation - Numerical procedure for SIMPLE algorithm – Boundary conditions for the pressure correction method - Stream function- Vorticity method, Discussion of case studies. Applications of CFD fluent software - Drying, Sterilization, Mixing, Refrigeration. Other applications – Heat exchanger, Clean room condition, Future of CFD in food industry.

9 Hours
Total: 45 Hours

References

1. J. D. Anderson., Jr. *Computational Fluid Dynamics- The Basic with Applications*, Tata McGraw Hill Publishing Company Pvt Ltd., New Delhi, 2004
2. P. Ghosdastidar, *Computational Fluid Flow and Heat Transfer*, Tata McGraw Hill Publishing Company Pvt Ltd., New Delhi, 2003
3. K. A. Hoffman, *Computational Fluid Dynamics for Engineering*, Engineering Education System, Austin, Texas 2005.
4. Muralidhar and T. Sundarajan, *Computational Fluid Flow and Heat Transfer*, Narosa Publishing House, New Delhi, 2002.
5. S. V. Patankar, *Numerical Heat Transfer and Fluid Flow*, Hemisphere, New York, 2004.
6. T. J. Chung, *Computational Fluid Dynamics*, Cambridge University Press, Chennai 2003.

13ED72 / 13CC73 PRODUCT RELIABILITY

3 0 0 3

Course Objectives (COs):

- To impart knowledge on reliability mathematics and reliability models
- To create expertise on product maintainability and introduce software reliability

Course Learning Outcomes (CLOs):

1. Improving knowledge in failure modes and effect analysis
2. Improving knowledge in accelerated testing concept
3. Increasing the software skill in reliability

Programme Outcomes (PO):

(c) Ability to design a system, component, or process to meet desired needs and solve engineering problems.

(e) Ability to research concepts, simulate, test working conditions and application of modeling methods and their impact on the designed systems.

(f) Ability to solve open-ended engineering problems in design engineering areas including the design and realization of such systems.

UNIT - I

Introduction

Definitions, stage gate approach, reliability mathematics, reliability models, parametric and catastrophic methods, reliability predictive modeling.

9 Hours

UNIT - II

Failure Modes and Effect Analysis

Goal and vision, concepts and types of FMEA evaluations, fault tree model.

9 Hours

UNIT - III

Evaluating Product Risk

Test design by failure modes and aging stresses. Aging due to cyclic force, Miner's rule.

9 Hours

UNIT - IV

Concepts in Accelerated Testing

Time acceleration factor, influence of acceleration factor in test planning, application to acceleration test, high temperature operating life acceleration model, temperature humidity bias acceleration model, temperature cycle acceleration model, vibration accelerator model, failure free accelerated test planning. Accelerated reliability growth.

9 Hours

UNIT - V

Product Maintainability and Introduction to Software Reliability

Maintainability concepts and analysis measures of maintainability, design for serviceability, supportability and maintainability preventive maintenance scheduling. Software reliability - Definitions, waterfall lifecycle, techniques to improve software reliability, software reliability models

9 Hours

Total: 45 Hours

References

1. Naikan V N A, "Reliability Engineering and Life Testing", PHI Learning Private Limited, 2009.
2. Prabhakar Murthy D N and Marvin Rausand, "Product Reliability", Springer-Verlag London Limited, 2008.
3. Dana Crowe and Alec Feinberg, "Design for Reliability", CRC Press, 2001.
4. John W Priest and Jose M Sanchez, "Product Development and Design for Manufacturing – A Collaborative Approach to Producibility and Reliability", Second Edition, Marcel Dekker, 2001.
5. Michael Pecht, "Product Reliability, Maintainability and Supportability Handbook", CRC Press, 2009.

13ED73 / 13CC74 PRODUCTIONS AND OPERATIONS MANAGEMENT

3 0 0 3

Course Objectives (COs):

- To impart knowledge on reliability mathematics and reliability models
- To create expertise on product maintainability and introduce software reliability

Course Learning Outcomes (CLOs):

1. Improving knowledge in failure modes and effect analysis
2. Improving knowledge in accelerated testing concept
3. Increasing the software skill in reliability

Programme Outcomes (PO):

(c) Ability to design a system, component, or process to meet desired needs and solve engineering problems.

(e) Ability to research concepts, simulate, test working conditions and application of modeling methods and their impact on the designed systems.

(f) Ability to solve open-ended engineering problems in design engineering areas including the design and realization of such systems.

UNIT - I

Forecasting Facility Location and Layout

Introduction, measures of forecast. Accuracy, forecasting methods, time series smoothing, regression models, exponential smoothing, seasonal forecasting, cyclic forecasting. Location factors, location evaluation methods. Different types of layouts for operations and production. Arrangement of facilities within departments.

9 Hours

UNIT – II

Aggregate Planning and Master Production Scheduling Inventory Analysis

Approaches to aggregate planning, graphical, empirical, and optimization. Development of a master production schedule, materials requirement planning (MRP-I) and manufacturing resource planning (MRP-II). Definitions, ABC inventory system, EOQ models for purchased parts, inventory order policies, EMQ models for manufactured parts, lot sizing techniques. Inventory models under uncertainty.

9 Hours

UNIT - III

Work Measurement and Scheduling and Controlling

Labour standards and work measurement 408, historical experience 409, time studies 409, predetermined time standards 413. Objectives in scheduling, major steps involved, information system linkages in production planning and control, production control in repetitive, batch and job shop manufacturing environment.

9 Hours

UNIT – IV

Just In Time Manufacturing and Project Planning

Introduction elements of JIT, uniform production rate, pull Vs push method, Kanban system, small lot size, quick, inexpensive set-up, and continuous improvement. Optimized production technology. Evolution of network planning techniques, critical path method (CPM), project evaluation and review technique (PERT). Network stochastic consideration. Project monitoring. Line of balance.

9 Hours

UNIT – V

Scheduling with Resource Constraints

Allocation of units for a single resource, allocation of multiple resources, resource balancing. Line balancing, Helgeson Brine approach, regionapproach. Stochastic mixed product linebalancing. Flexible manufacturing system, concepts, advantages and limitation, computer integration and in manufacturing and operations. Electronic data interchange.

9 Hours

Total: 45 Hours

References

1. Bedworth D D, "Integrated Production Control systems Management, Analysis, Design", John Wiley and Sons, New York, 2007.
2. Dilworth B James, "Operations Management, Design, Planning and Control for Manufacturing and Services", McGraw Hill, Inc, New Delhi, 2006.
3. Jay Heizer and Barry Render, "Operations Management", Eighth Edition, and Pearson Education, 2005.
4. Vollman T E, "Manufacturing Planning and Control Systems", Galgotia Publication (P) Ltd., New Delhi, 2004.

13ED74 MECHANICS OF FRACTURE

3 0 0 3

Course Objectives (COs):

- To identify and formulate fracture toughness of materials, this leads to safe design.
- To expose to fracture mechanics and failure analysis tools.
- To predict the fatigue life of structures using fracture mechanics approaches.

Course Learning Outcomes (CLOs):

1. Understanding about material selection process and fracture behaviour of different materials.
2. Ability to select materials for different engineering applications based on various criteria.
3. Ability to solve research and engineering problems using fracture mechanics principles and approaches..

Programme Outcomes (PO):

(c) Ability to design a system, component, or process to meet desired needs and solve engineering problems.
(f) Ability to solve open-ended engineering problems in design engineering areas including the design and realization of such systems.
(i) Ability to identify engineering problems, and to carry out the engineering design of a system or component to meet desired needs, using modern tools for complex design.

Unit – I
Elements of Solid Mechanics
The geometry of stress and strain, elastic deformation, plastic and elastoplastic deformation-limit analysis

9 Hours

Unit – II
Stationary Crack under Static Loading
Two dimensional elastic fields-Analytical solutions Yielding near a crack front-Irwins approximation-plastic Zone size-Dugdale model-J integral and its relation to crack opening displacement

9 Hours

Unit – III
Energy Balance and Crack Growth
Griffth analysis-Linear Fracture Mechanics-Crack opening displacement-Dynamic energy balance-crack arrest

9 Hours

Unit – IV
Fatigue Crack Growth Curve
Empirical relation describing crack growth by Fatigue-Life calculations for a given in load amplitude-effects of changing the load spectrum-Effects of Environment

9 Hours

Unit – V
Elements of Applied Fracture Mechanics
Examples of crack-growth Analysis for cyclic loading-leak before break- crack initiation under large scale yielding-Thickness as a Design parameter-crack instability in Thermal or Residual-stress fields

9 Hours
Total: 45 Hours

References

1. R. J. Sanford, Principles of Fracture Mechanics, Pearson Education, Inc. Upper Saddle River, 2003
2. 2.David Broek, "Elementary Engineering Fracturwe Mechanics", Fifthoff and Noerdhoff International Publisher, 2005
3. Kare Hellan, "Introduction to Fracture Mechanics", Mc Graw Hill Book Company, 2003.
4. Preshant Kumar, "Elements of Fracture Mechanics", Wheeler Publishing, 2004.
5. T L.Anderson , *Fracture Mechanics: Fundamentals and Applications*, CRC Press 2005.
6. Tribikram Kundu, Fundamentals of Fracture Mechanics, CRC Press, Boca Raton, 2008
7. Dietmar Gross and Thomas Seelig, Fracture Mechanics with an Introduction to Micromechanics, Springer, The Netherlands 2006.
8. http://www.elsevier.com/locate/enfracmech